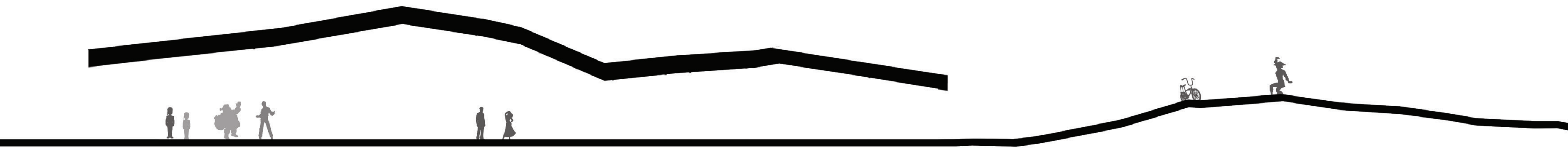


SUSTAINABLE KINDERGARTEN IN KAROLINELUND

TITEL PAGE

PROJECT
Master thesis

TITEL
Sustainable kindergarten in Karolinelund

FIELD OF STUDY
Architecture

PROJECT GROUP AND SEMESTER
Group 30, MSc04 Ark

PROJECT PERIOD
01.02.2017-18.05.2017

NUMBER OF PAGES
91

COPIES
4

SUPERVISOR
Mogens Fiil Christensen

TECHNICAL SUPERVISOR
Michal Zbigniew Pomianowski

Sarah Lund Christiansen

ABSTRACT

This thesis is based on Aalborg municipality's tender for a new kindergarten in Karolinelund. The kindergarten is designed with a focus on children's differences and on the development of their motor skills. The surrounding context is continuously under development which is why this design proposal is an example of what the future of Karolinelund could look like.

The kindergarten has a focus on sustainability where several technical aspects have been worked with, such as materiality, indoor climate, and the energy frame. Through the report, this has been documented through the use of software such as Bsim, BE15, and Velux daylight visualizer.

READING GUIDE

This thesis report is divided into three different sections: program, process, and presentation that will be finished off with a conclusion and reflection.

The program contains the preliminary studies, analysis, and theories which lead to the vision and the functional diagram of the kindergarten.

The design process illustrates how the design has developed from conceptual design ideas to more tangible and visual concepts for the building that both incorporates aesthetic- and the technical aspects and then leads to a final building design.

The presentation illustrates various visualizations of the final kindergarten design including its technical aspects.

Finally, the reflection discusses what could have been done differently based on the conclusion that discusses to what extent the building lives up to the vision formulated earlier in the program.

TABLE OF CONTENTS

INTRODUCTION TO THE THESIS

The aim of our master thesis is to design a kindergarten located in Karolinelund in Aalborg, Denmark. The project should have a sustainable approach. The integrated design process(IDP) will be used as the methodology. The process will be iterative and will include a holistic integration of sustainable and theoretical approach without compromising the building's aesthetic qualities.
The project takes inspiration from the local plan which is given by Aalborg municipality. This thesis will be based on the competition by Aalborg municipality for a new kindergarten in Karolinelund.
The competition: Aalborg municipality's vision for the kindergarten is a new building that fits into Karolinelund's unique atmosphere as a green park and an amusement park. The kindergarten should house 100 children and the total build area should be around 850 square meters.
The architectural quality of the design of the building should be continuous. From the main idea to the choice of materials and the detailing.

METHODOLOGY

The method used in this thesis is the integrated design process by Mary-Ann Knudstrup. The method is based on problem-based learning and describes how a design can be developed through a combination of technical knowledge, aesthetics and spatial-bound design processes.
The integrated design process is divided into 5 phases starting with the problem phase. The second is the analysis, the third is sketching and design, the fourth is the synthesis and lastly, the fifth phase is the presentation phase. These 5 phases will be formed as an iterative process. (Knudstrup, 2004)

Problem phase:
The entire prelude to this project is the problem phase. In this phase, the idea or problem, which forms the project, gets defined and described. For this project, the problem definition has been based on the tender for a new kindergarten in Karolinelund by the municipality of Aalborg.

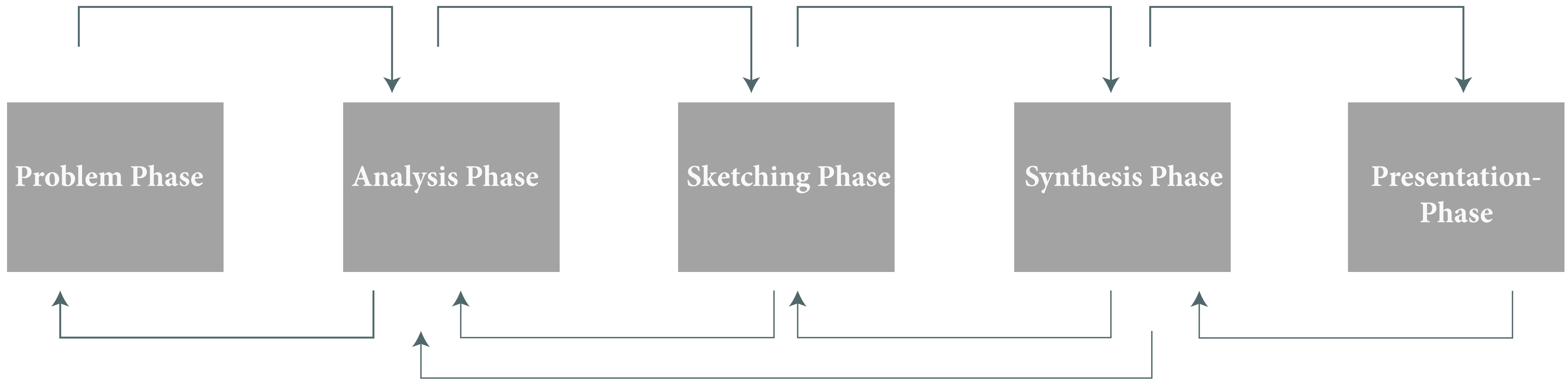
Analysis Phase:
The goal of the analysis part of the project is to examine the site condition to describe an approach for the aesthetics, functionality and technical features of the project. When analyzing the site, the approach of phenomenology has been used. This analyze was made when the group was at the site and had a discussi-

on while experiencing the condition of the site etc. Document analysis and phenomenological analysis has been done to gather more information about the history of the site. Furthermore, the same approach is used for the case studies along with the phenomenological knowledge from visits to the two case studies.

Sketching and design phase:
This phase of the project is an iterative process, where sketching, 3D visualization, and physical models are used. The various sketching tools give the opportunity of understanding the different aspects of the design which also benefits the design solutions and makes it possible to optimize the design.
This phase is intensively iterative where the different design decisions need to be held up against the analysis. This phase continues until a clear design concept is chosen where the analytical and critical parts are evaluated in the perspective of the aesthetics, technical qualities, and functions.

Synthesis Phase:
In the synthesis phase, the final design takes shape based on the process and knowledge from the previous phase.
It is in this phase where it all comes together, both the architectural overall design, the technical aspects, and the architectural details.
It is important to start this phase early on in the thesis to ensure that the technical aspects are not forgotten and works in collaboration with the aesthetics and the functionality.
Technical calculations and simulation tools such as Bsim, Be15, and Velux light analysis are used to implement and reach a sustainable building design solution.

Presentation Phase:
This is the concluding phase where the project is presented so to show its strengths, qualities and how the vision and design criteria's are achieved. The presentation materials will include the final design of the Kindergarten within the final site plan and context, sections, elevations, visualizations and physical models. The presentation materials aim to show the qualities of the indoor and the outdoor areas.
(Knudstrup, 2004)



Ill.1: Diagram of the itterative process

PROGRAM

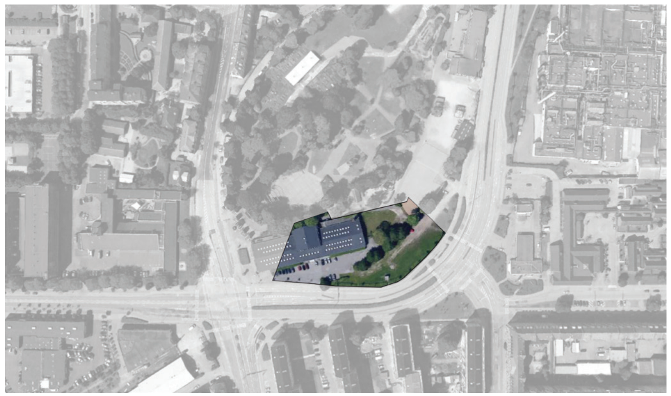
LOCATION OF THE SITE

Karolinelund is located in the eastern central part of Aalborg. The site is located in the southern part of Karolinelund (ill. 4). Towards the northern part of Karolinelund, the renewed waterfront offers Musikkens hus, Utzon Center, University facilities, Aalborghus Slot, the main library, and Nordkraft. This part of the city is very attractive for young people as there are a lot of activities going on. Toward the southern part of Karolinelund, there are dwelling areas for families and young people, especially Øgadekvarteret which is a closed community within the surroundings of Aalborg. Tulip factory is located east of the site.

Ill.2: Jutland

Ill.3: Aalborg

Ill.4: Karolinelund



Ill.5: The site

KAROLINELUND

Karolinelund is one of the most popular parks located in the heart of Aalborg. It was established in 1946 by the Lind brothers. In the mid 70's the place was changed into an amusement park. Unfortunately, Karolinelund Tivoli was closed and sold to the municipality of Aalborg due to the deficit in 2007. The municipality of Aalborg took the control of Karolinelund Tivoli in 2010 and decided to stop operating the amusement park. Later, Karolinelund was reconstructed as a city park.
The park offers different cultural activities such as concerts and artistic shows. Furthermore, several places in Karolinelund were redesigned as green areas and sports areas in 2013. At the same time, the municipality reserved some areas for other purposes. In October 2015 the municipality decided to build a new kindergarten in Karolinelund. The vision of Karolinelund is to create a local park that includes a different range of activities. Here, the construction of a childcare institution has been pointed out. Furthermore, the purpose of the park is to keep the nature related characteristics by maintaining old trees of the park. This gives character to the park by appearing as a quiet oasis in the center of Aalborg (delimited by a surrounded wall). The vision for the park takes on five substantial elements in depth; 1. Trying to keep the area as green as possible by keeping old trees and making sure that there is space to plant new replacements.
2. Trying to create accessibility from the outside, so the park also can be used as a shortcut and/or destination.
3. Strengthening and developing the edge or border of the park through developing objects which works by shielding Karolinelund from the noise and gives the area a peaceful atmosphere.
4. Combining Østerå with Karolinelund so it works as one natural element.
5. One of the major advantages of the park is that it is used by different age groups, due to the many actives which are possible in the area. These makes it possible for creating places where the different users can meet, but still it making it possible to be separated to prevent conflicts between the age groups.
These elements were decided by the municipality to create the framework for the future of Karolinelund. (the new "helhedsplan")


Ill.6: The past of Karolinelund


Ill.7: Karolinelund Today


Ill.8: The future of Karolinelund

ANALYSIS OF THE SITE

Located on the east side of Karolinelund is the company Tulip Food Company. The company has a risk zone around it. This is made as an Impact distance in the case of ammonia emissions from the company's refrigeration plant. Because of this impact distance from Tulip, it is not possible to build on the east side of the site. The construction zone is, therefore, the part of the site that is not affected by the impact distance from tulip (Ill 10).

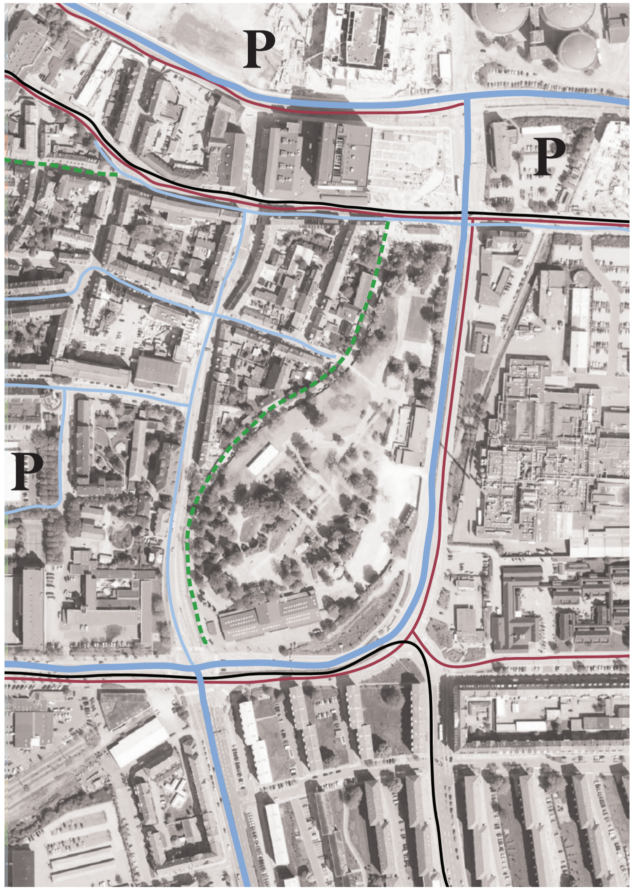
It is possible to arrive at the site by public transportation, bike, and car, though there is not any parking right now in a very close proximity to the site, it is noted in the tender that will be in the future.

The noise map illustrated on the next page is made by the "Miljøstyrelsen" in 2007 but because of the demolition of the old Tæppeland building, it is expected to be even higher today in the south part of Karolinelund. Therefore it is necessary to create a noise barrier on the southern part of the site. This has already been suggested by the "Helhedsplan Karolinelund" to take shape in the form of hills on the southern part of the site.

It has been decided by the Aalborg city council that Østerå should be opened through Karolinelund and they have therefore reserved an area in Karolinelund to make this possible as showed in Ill 13.

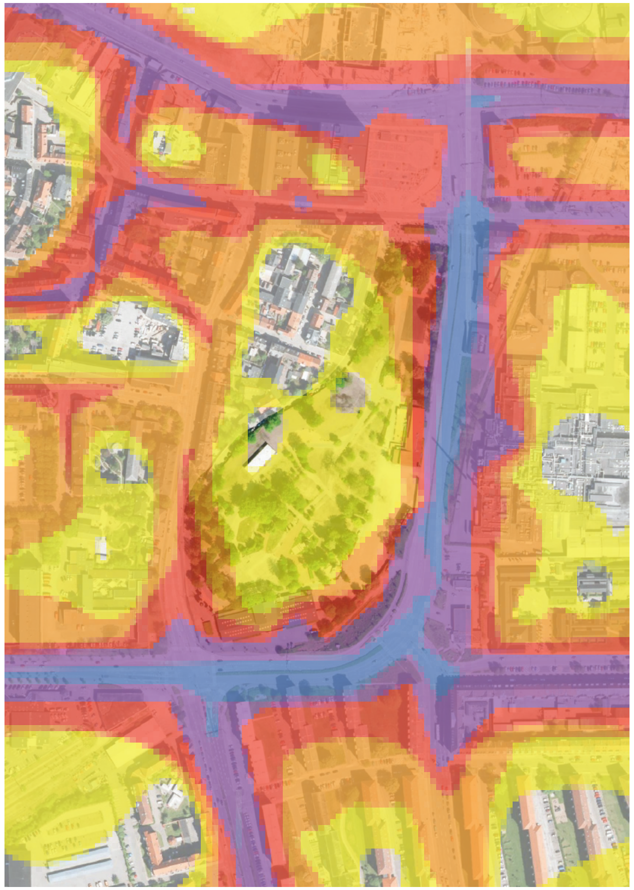
Ill.9: The site

Ill.10: Impact distance to Tulip



Primary road
Secoundary road
Pedestrian path
Bus routes
Bike routes
P Parking

Ill.11: Trafic



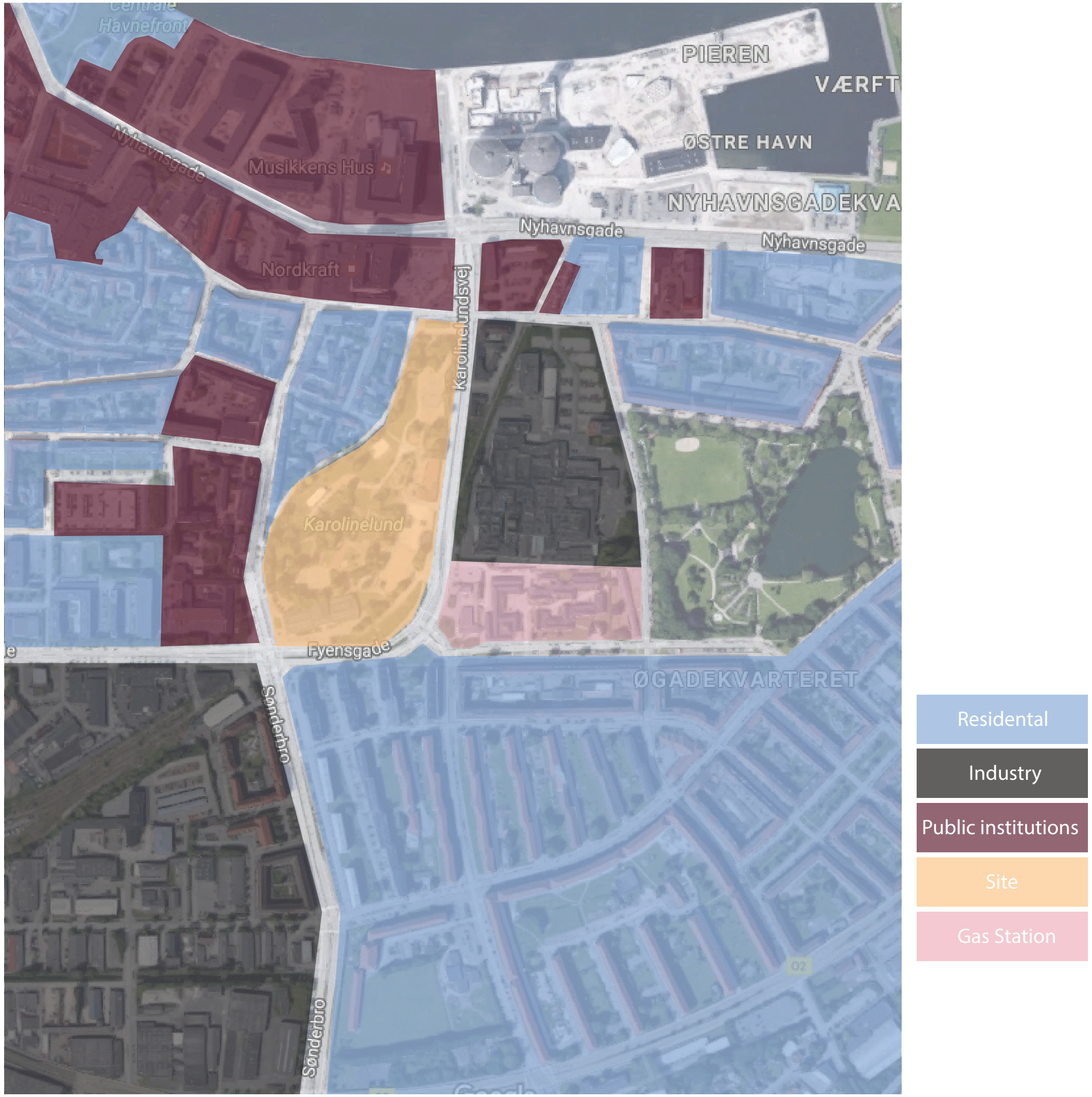
Over 75 dB
70-75 dB
65-70 dB
60-65 dB
55-60 dB

Ill.12: Noise in city 1.5m from 2012

Green area
Blue area (Østerå)

Ill.13: Map of green and blue areas

ANALYSIS OF THE SITE - SURROUNDINGS



Ill.14: Surrounding areas

ANALYSIS OF THE SITE - SERIAL VISION


Ill.15: 1. Entrance


Ill.16: 2. Before the football ground


Ill.17: 3. After the football ground


Ill.18: 4. Before the volleyball area

Ill.23: Map of the route


Ill.19: 5. Platform 4

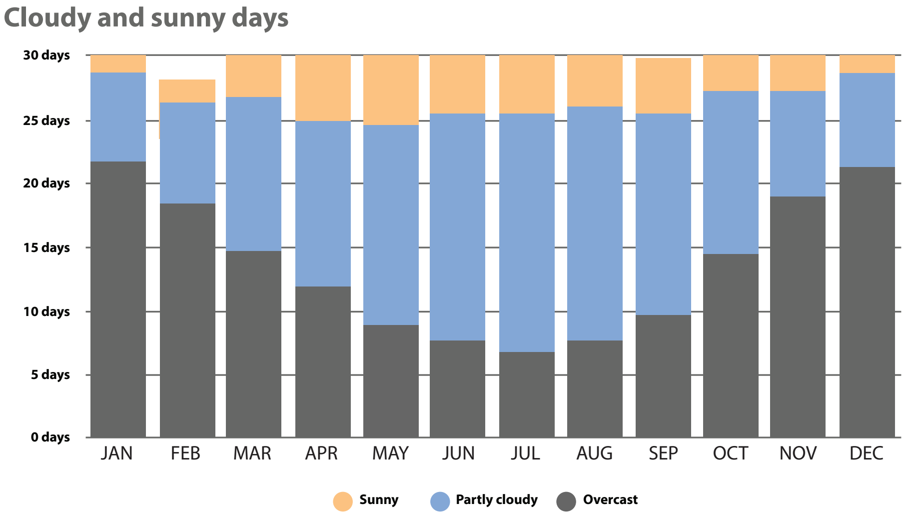

Ill.20: 6. Volleyball area


Ill.21: 7. Crossroads facing towards the small windmill

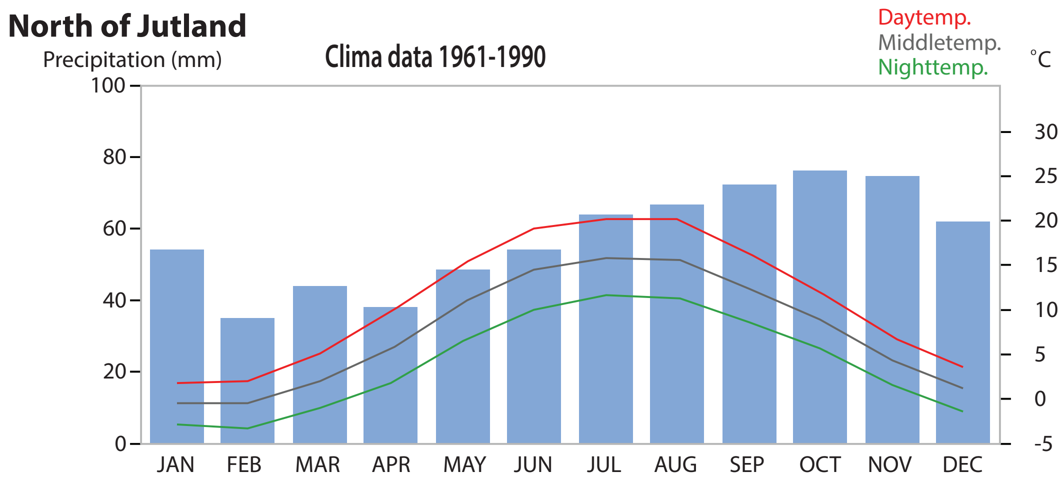

Ill.22: 8. The new building under construction

ANALYSIS OF THE CLIMATE - TEMPERATURE/PRECIPITATION/SUN

The weather in Denmark is characterized by summers with average temperatures around 16 °C and moderate winters with an average temperature around 0.5 °C. The precipitation is continuously throughout the whole year, which can be seen in Ill 25, where the amount of precipitation is highest in autumn and lowest in the spring. In Denmark, the skies are dominantly overcast, as shown in Ill 24 which explains about the cloudy and sunny days, where it is only partly cloudy or sunny a few days in a month. This depends on the months, though, where the skies are more clear in the summer months and more overcast in the winter months.



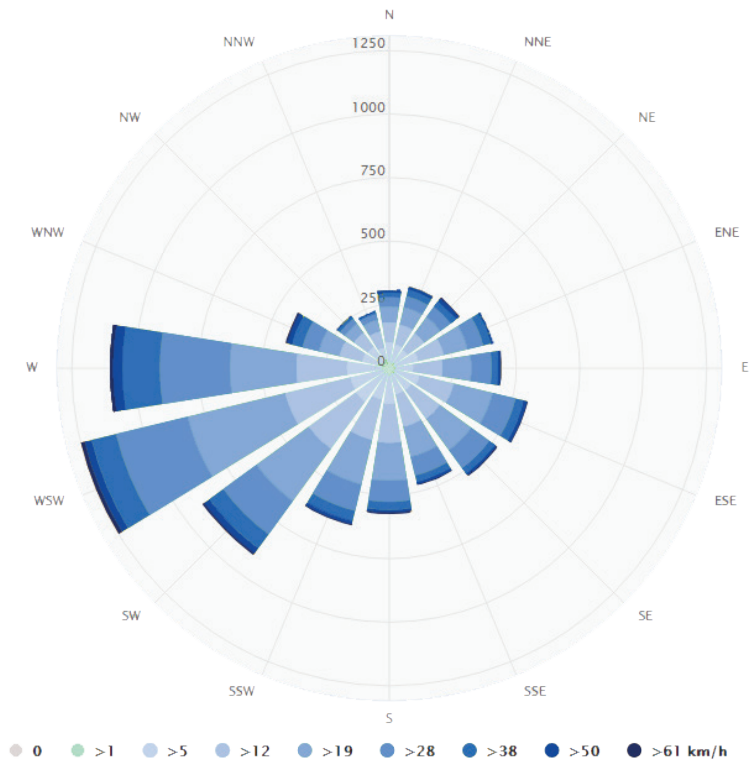
Ill.25: Diagram of sunne and cloudy days in Aalborg



Ill.24: Diagram of temperature and persipitation in the region of the north of Jutland

ANALYSIS OF THE CLIMATE - WIND

The dominant wind direction in Denmark is primarily from the west and southwest direction, as shown in Ill 26. The density of the city is one of the major factors which affects the air velocity on the site. The buildings protect the interior of the blocks, but the gaps in between buildings are strengthening the air velocity, which is also the case for how wind tunnels are created on the street. The air velocity goes up to 13 m/s when it is at its highest.



Ill.26: Windrose of Aalborg

DANISH KINDERGARTENS AS A TYPOLOGY IN A HISTORIC PERSPECTIVE

In 1828 the first children asylum in Denmark opened by the female charity banquet with Frederick the VIs and Queen Marie in the lead. These were the predecessors of the daycare we know today. The first children asylums were funded by private individuals as part of a charity project for poor families that could not handle childcare while working. The purpose of the children asylums was to teach the children discipline, order and to give them the skills that were needed for a further education. The asylums were part of that period's social services where the richer part of the population paid for and helped the poorer part by creating institutions etc. (Holm et al., 2004)
The children asylums were often placed in villas or apartments and were equipped with a school room and a sleeping room. The school room was equipped with an asylum staircase where the children slept, read and played, which made it possible for one teacher to look after many children at the same time. It was not until the postwar period of the second world war that there was put an extra effort into making new buildings specially designed for institutions. This resulted in the standardization of the new buildings that often could house many children. (Gammelby, 2013)

Frederich Frøbel was a German pedagogue (1782-1852) that after having worked with bigger children for some years decided to create an educational service/institution for smaller children. In 1840 he issued his "Theses about the kindergarten". Frøbels idea for a new kindergarten was not just revolving around childcare but also contained ideas about pedagogy and politics. Frøbel saw the kindergarten as being a place where the citizen could get new possibilities. After Frøbel issued his theses he began to educate teachers in this new field. (Holm et al., 2004)

In 1873 Frøbels great-niece founded the Pestalozzi-Frøbelhaus Seminary. It was here that most of the Nordic pedagogy pioneers were educated and here that some of the key traits for the public kindergarten in Denmark were formulated. The Public kindergarten grew out of the recognition that it was necessary for both the father and the mother to be working if their household economy should function. The pedagogy that was used in the new public kindergartens was built on the understanding that the child was playful and creating. A new thing in the public kindergartens was that the children were divided into smaller groups of approximately 20 children, the rooms were shaped to mimic the home environment and the rooms were often equipped with many tables and chairs turned towards the teacher like in a school so the children's attention were directed towards the teacher. (Gammelby, 2013) (Holm et al., 2004)

Maria Montessori (1870-1952) was the first female doctor in Italy. She choose to focus on pedagogy rather than medicine. Montessori was influenced by the scientific approach of her time and saw the children's imagination as being important. Instead, she worked towards developing the children's knowledge in mathematics and languages, through the use of their senses, by using materials with specific didactic purposes. (Holm et al., 2004)

The first kindergarten in Denmark was established in 1871 in Copenhagen by Erna Juel-Hansen. She was a Zahle educated teacher and kindergarten teacher. (Holm et al., 2004)
The social reform of 1933 included the kindergarten in the law as a preventative social institution. Here daycare institutions were defined as the preventative care in the child services and the 24 hours care were seen as the shielding care. (Holm et al., 2004)
In the 1940's and 1950's, there were many companies that established kindergartens for their employees so to ensure female employees. But this became rather problematic because the children got attached to their parent's workplace instead of a local community. (Holm et al., 2004)

In 1964 the Danish parliament passed a law on child and youth welfare that stated it was the duty of the municipality to have the necessary spaces for children in daycare. This was the start of institutionalizing the childhood that had gone on until this day. (Gammelby, 2013) The new drawings for institutional buildings had to be approved by the social ministry. The ministry's architectural consultant and leading administrator, Thomas Having, made some pattern drawings for daycares that were inspired by his earlier work for central schools. This resulted in kindergartens that like Having's central schools had long hallways that separated the rooms for the teachers such as meeting rooms and offices on one side of the hallway and the rooms for the kids on the other side. The signals this typology sent were more like a clinical, clean and almost hospitalized daycare building. (Gammelby, 2013)

In 1963 architect Max Siegumfelt got his drawings for a new typology approved by the social ministry. This new typology was revolutionary because instead of the earlier school rooms he now suggested the use of group rooms and small group rooms instead. These rooms were smaller in size and the children were now divided into smaller groups and assigned to one of these rooms that had their own group of teachers. (Gammelby, 2013) Because of women entering the workplace in the 1960's, there was now a bigger need for childcare and this resulted in many kindergartens being built in the 1960's.

In the 1970's a new typology broke through that consisted of a big and flexible room where it was possible to put up partition walls as a way of dividing the big room into smaller sections. By doing so it was possible for the teachers to make the room to their liking. (Gammelby, 2013)

In the mid-1990's a focus on supporting the children's aesthetic learning process was in session. There was now a focus on a good natural lighting in the building and inspiring the children's senses with the help of the building. (Gammelby, 2013)

In the 1980's and 1990's, a new debate arose about the square meter space of free floor area for each child in the kindergarten and how it affected the indoor climate and the contamination risk amongst the children. This debate was among others based on a sample survey from 1992 by Medical Officer Anne Rindel. The survey that was conducted concluded that if the free floor square meter space for each child was raised by just one m^2 from the two m^2 that was required then, and still is today, to three m^2 then the number of sick days would drop by 9.8 percent per child. (Gammelby, 2013)

If there is too little space in a kindergarten it can also lead to a too high level of noise. A study done by BUPL measures the sound in 52 kindergartens. The study showed that the average sound level was 79.9dB. This meant that half of the institutions had a sound level higher than the limit of 80dB. This is the limit that the Working Environment Authority has set, for people to start wearing ear protection when working.(Albæk Nielsen & Nygaard Christoffersen, 2009)

As mentioned above the requirement of minimum space for each child in a kindergarten is still two m^2 of free floor area today and is described in the building regulations 2010. But psychological research has shown that when there is less than three m^2 of free floor area per child, there is a decrease in the number of children in the playroom, a decrease in group play and an increase in aggressive behavior amongst the children. (Kampmann, 1994) (Gammelby, 2013)

The two m^2 of free floor area rule was introduced in the 1920's where the pedagogical outlook was more scholastic than it is today. At this time the children were occupied with the same thing at the same time.

There is a debate around whether or not the rule needs to be changed because when it was introduced the need for more space to move around was not there as it is today with the new outlook on pedagogy. (Kirkeby, Gammelby, & Dyhring Elle, 2013)

MOTER SKILLS DEVELOPMENT IN CHILDREN

Perception of the body and motor learning are closely linked because the senses send signals to be used by the child to learn and coordinate its movements. It is a prerequisite for the child to develop motor skills since all of its senses contributes with vital information concerning that movement the child is about to make or is making. Sensory perception is what provides us, and the children, with information about what is happening in our surroundings and provides information about our own bodies. The child needs to be able to interpret the stimuli correctly and be able to integrate the stimuli in a meaningful way. For this to be able to happen there is a need for an interaction between the motor skills and senses. This is depended on an integration of the sensory impressions. The interaction between the child's motor skills and its senses is dependent on sensory impressions. This means that the child needs to be able to interpret the sensory stimuli correctly in order to integrate them together.

The development of motor skills in children is also dependent on the possibility for different experiences in different scenarios. The more movements the child learn to master the more experiences the child gets with that movement which can then be used for planning new movements.

Good motor skills have a big impact on the child's self-esteem, it strengthens the child's ability to be physically active and it also has an impact on how the child participate in social setting.

(Maxmilling, Kristensen, & Piilgaard Hansen, 2016)

Ill.27: Implementing playtools in walls

Ill.28: Implementing playtools in the floor and ceiling

LIGHT IN KINDERGARTEN

Achieving a good light quality in a kindergarten is not only important for the adults working at the institution, but also for the children due to the improvement of their development in several ways such as sight, movement, and balance skills.

The importance of a good light quality is often forgotten in several rooms in kindergartens, due to the lack of planning of the natural light, which has to be done in the early stage, while doing the designing and the floorplans. If it gets done later, it might be impossible to illuminate the rooms properly. The sense of the sight is mostly developed during the childhood. In fact, around 70-80% of all sensory impression are done through the sight.

Kjeld Johnsen claims that the best light for children is natural daylight, which can be obtained even in already existing buildings. This can be done by having white window frames while ensuring that there isn't any furniture indoors that block the light and prevent trees and bushes from blocking the daylight that enters the room as well.

Additionally, there should be screening for preventing direct daylight. Furthermore, this screening should be in colors, which doesn't change the colors of the natural light.

The children play in many different ways, which varies from playing on the ground, at a table or while standing, which makes it important to have flexible lighting, where it is possible to vary the light by having low placed windows or spotlight. It should be possible for adjusting the light, and at the same time create spots for the children to play in. When having a spotlight around a table it is important to place the light so it doesn't blind the children, reasoning that the children face are often lower placed than adults, and at the same time they often look upwards, and learn from observing adults' face expression and body language. More varieties in lightning promote the creativity of the children.

Ill.29: using natural spot lights

Ill.30: Opening up for natural light

CASE STUDY - SOLHUSET

Solhuset is an environmentally friendly building that was built in 2011 by CCO Architects in cooperation with Velux and Rambøll engineers. The building is located in Hørsholm, Denmark, and is 1300 m^2 and contains 100 children and 30 adults.
The vision of the building is to create a holistic view for architects, for how to create a building which positively affects the human health, which is done through the indoor- and outdoor climate, in cooperation with renewable energy. The focus of the indoor environment is to create daylight and fresh air.
The footprint of the building is shaped like a triangle. The roof of the building is pitched in several places, which makes the building expression dynamic. On top of the roof, is placed both PV and solar collector panels to incorporate renewable energy into the building so that the building doesn't use more energy than what it consumes as part of one of the strategies in an active house. Furthermore, the architects have played with straight lines through, the facades, roof and the windows. The materials for the facade is wood, which is painted black.
The first impression when entering the building is an open area, with a low amount of activities due to the placement of the main entrance, and due to the fact that the heart of the building is mainly used as a canteen, where the children get to eat in shifts divided by age. This area is pretty much a dead zone except for lunch time. When walking deeper into the building the room geometries differs, which gives the kids an experience, but at the same time makes the flow complicated to understand for the adults. The connection between the rooms is well functioning because of the necessity of the adults assisting each other in case of problems or sickness.
When visiting the building, the staff described what they found were the pros and cons of the building. Overall the rooms are well used, but lacking when it comes to how the children can be challenged in form of learning but also movement, even though there can be some changes which can incorporate this. In Solhuset, they had tried to use moveable objects for incorporating working with the senses, but this made some of the rooms very chaotic. This could have been helped by changing some of the objects to fixed object and incorporating them in the walls and floors.
There are two rooms which are connected with the outdoor. These rooms can be looked into from the inside and are randomly used at the moment, but could easily be adapted to be used as a greenhouse or for keeping rabbits. This would give the children an experience to participate in and look at.
The indoor climate of the building works very well. As a testament to this, it was stated by several of the staff that since coming to work at Solhuset none of them ever had a headache which they had experienced several times at their old place of employment because of a bad indoor climate. The only problematic part of the building is in the nursery where it, in the summer time, can become very warm because of the orientation of the windows.


Ill.31: The outside of Solhuset


Ill.32: The Outside of Solhuset


Ill.33: Grappleroom


Ill.34: Commenspace

CASE STUDY - MARTHAGÅRDEN

Marthagården is known for being one of the most sustainable kindergartens in Denmark. The building is located in Frederiksberg. The size of the building is 1000 m^2 and contains around 130 children. It was renovated in 2013, but the project planning was started early 2008, but due to several problems, the project got extended.
Earlier there were two kindergartens which were separated into two buildings, but when renovating the building the architects, Lendager Group, was asked to combine both of the buildings. This was done by creating a building in the middle which is now used for connecting both buildings but at the same time used as a barrier from the traffic noise and a protection for the children from this as well. The middle building is also used as the heart of the building, where the children start their day with eating breakfast, and later in the day works as the central point when there aren't many children in the kindergarten. The building is constructed with materials that are friendly to the children and to the environment.
Walking through the building, each room gives a different experiences, due to the different colors, the shape of the room and the personal touch each child has made for the room. Furthermore, the children are involved in learning the procedure of harvesting vegetables. The children are learning to share their toys, at an early age, by giving unused toys which can be picked up by other children and be used by them.
From the outside, it is pretty clear that the building is combined with two different institutions. This can be a confusing element since it is one building, which can be seen in Ill. 35. Where two part of the building is concrete and have two different colors, red and grayish yellow, the extension is made out of wood. Aesthetically it is confusing due to the fact that it is three renovated buildings which have been combined, but it functions well for its purpose which is being a kindergarten and nursery.

Ill.35: The outside of Marthagården

Ill.36: The playground

Ill.37: Inside planters

Ill.38: Zone dividion

TECHNICAL APPROACH

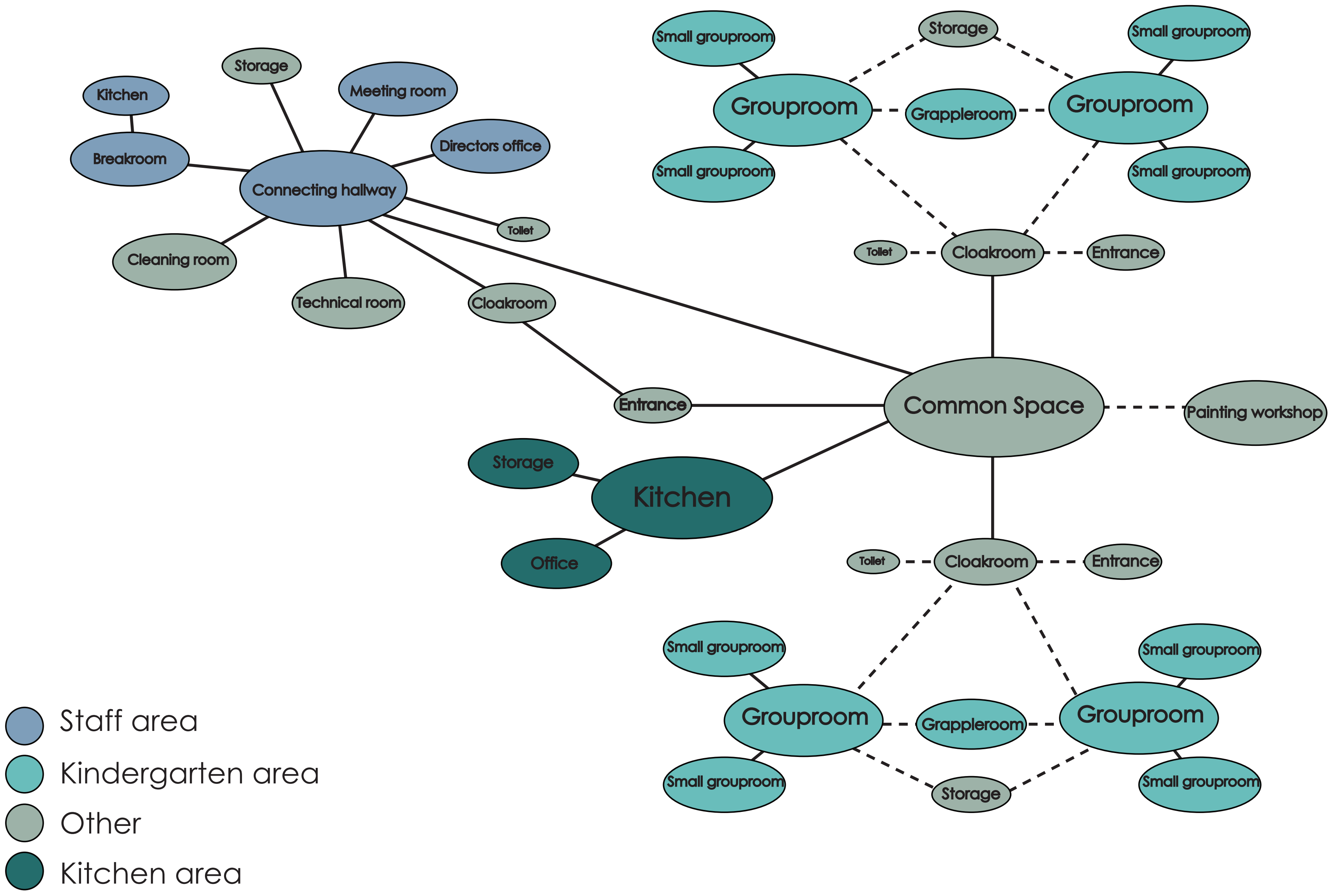
The technical approach for this project is to create a building that is focused on fulfilling the building regulations in the future, which is why the aim is to reach BR2020 requirement. The requirement states that the usage cannot exceed more than 25 kWh/m^2 annually. (BR20, 2014) For ensuring the thermal comfort for the users of the building, the aim is to stay around 22˚ C. At the same time the building must not exceed more than 100 hours of 26˚ C and 25 hours above 27˚ C annually (DS 474, 1995). To achieve atmospheric comfort CR1752, table A.5 category B is followed and tells about requirements in buildings for obtaining atmospheric comfort, where the dp must maximum be 1.4, for having an amount of 20% who are dissatisfied. Sensory pollution load done by children in an age of 3-6 is found in CR1752, table A.6 and are 1.2 olf, and carbon dioxide generated is 18 l/h. The CO_2 concentration outside is above 500 ppm, and inside concentration must not be above 660 ppm from the outdoor ppm, following category B.
Daylight is an important factor, for the health of the children in a kindergarten, according to BR2020, a workspace demands a minimum of 2% DF, which are seen as a healthy environment for the user of the building.
After reaching below 25 kWh/m^2 renewable energy will be applied to become a zero energy building. (BR20, 2014)

ROOM PROGRAM

4x	Group rooms	35 m^2
8x	Small Group room	17 m^2
4x	Storage	10 m^2
4x	Grapple room	20 m^2
2x	Secondary entrances	7 m^2
1x	Main entrance	25 m^2
4x	Cloakroom	15 m^2
1x	Workshop	30 m^2
4x	Toilet	12 m^2
1x	Kitchen	50 m^2
1x	Cleaning room	15 m^2
1x	Technical room	20 m^2
1x	Break room	20 m^2
1x	Staff kitchen	6 m^2
1x	Meeting room	15 m^2
1x	Director office	12 m^2
1x	Commonspace	100 m^2
	In total	811 m^2

Ill.39: Room program

FUNCTION DIAGRAM



Ill.40: Function diagram

VISION

The ambition of the project is to design a kindergarten that has a focus on a sensory experience, where the architecture provides the framework for the children's learning and the architectural qualities come together in a synthesis in the form of the materials, natural light, colors, and shapes.
Furthermore, the thesis should aim to have a sustainable approach with a focus on the materiality and the indoor climate by following the 2020 regulations

DESIGN CRITERIA AESTHETIC

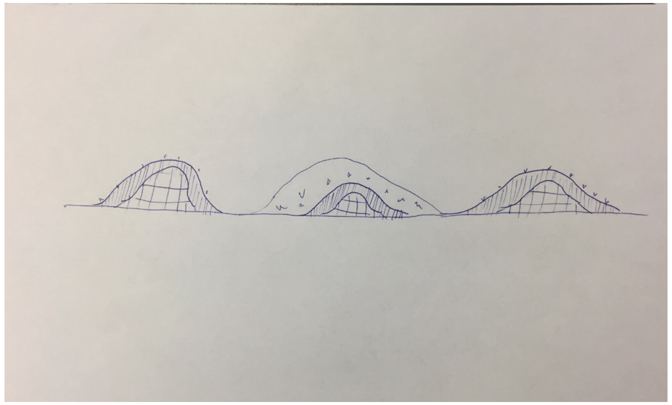
- Bringing sensory experiences into the architecture:
  - Different heights
  - Colors
  - Materials
- Using natural light in the building
- Possibility for the children to cultivate their differences
- Easy access from the group rooms to the outdoor areas
- Zone division with a visual contact between the children and the staff
- Variations in the plan design depending on the different zones in the building

DESIGN CRITERIA TECHNICAL

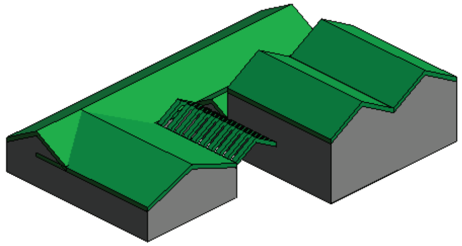
- A minimum of 3% daylight factor:
  - Good indoor climate
  - Natural ventilation
  - Thermal indoor climate
  - Noise
  - Materials
- Making a barrier for the noise
- Sustainable materials
- Follow Br2020
- Hybrid ventilation - VAV and mixing ventilation

DESIGN PROCESS

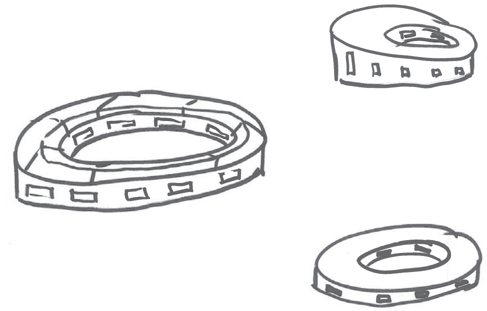
FIRST IDEAS



Ill.41: Sketch of organic form

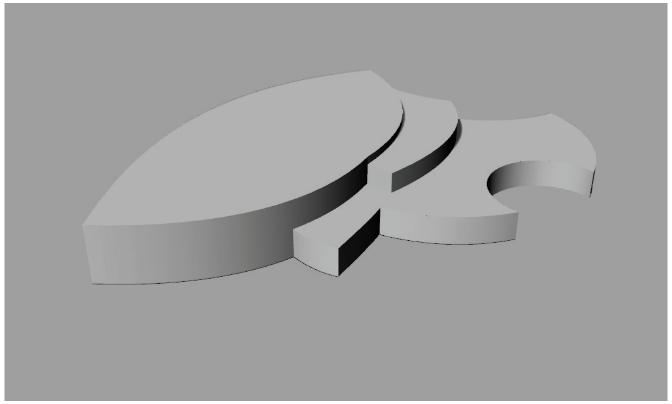


Ill.42: 3D modeling traditionel form

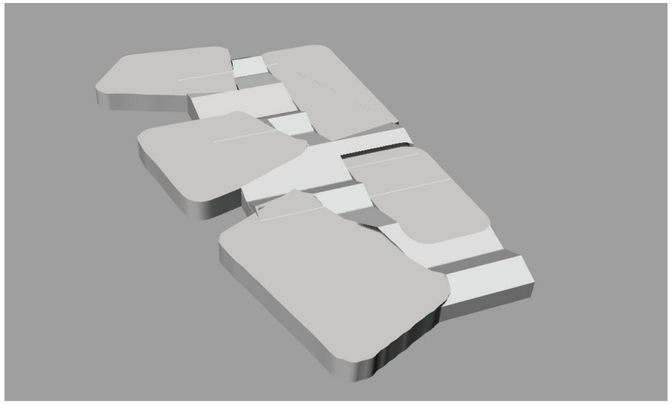


Ill.43: Sketching circular shapes

Ill.44: Facade idea



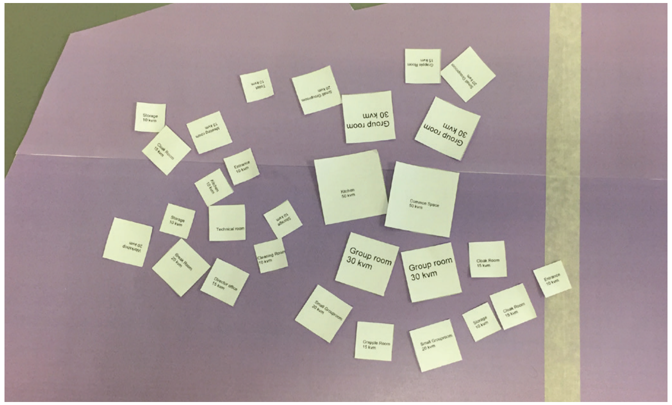
Ill.45: 3D modelling organic form



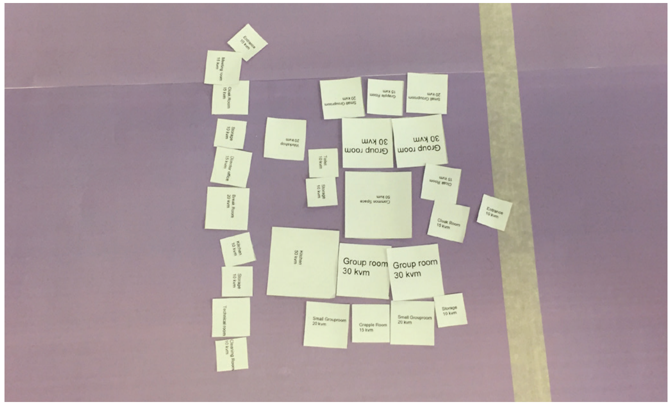
Ill.46: 3D modelling a combination of cubic shapes

In the first phase, we worked with different forms and shapes, which could fit into the project. There was no limitation and every idea was created through hand sketching and 3D-modelling. There were several different ideas, varying from organic to geometric forms.

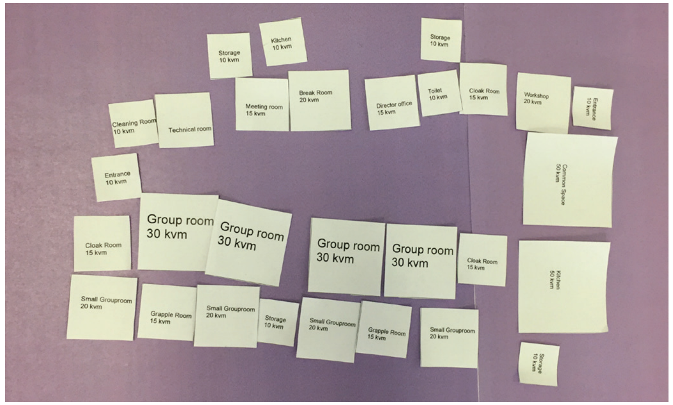
STUDIES OF CONNECTIONS BETWEEN THE ROOMS



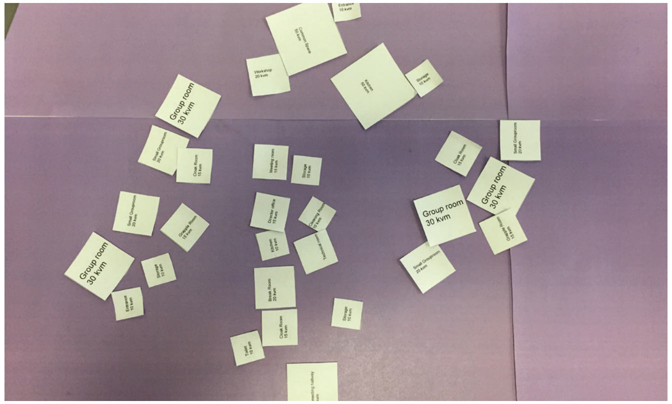
Ill.47: Experimenting with placement of functions



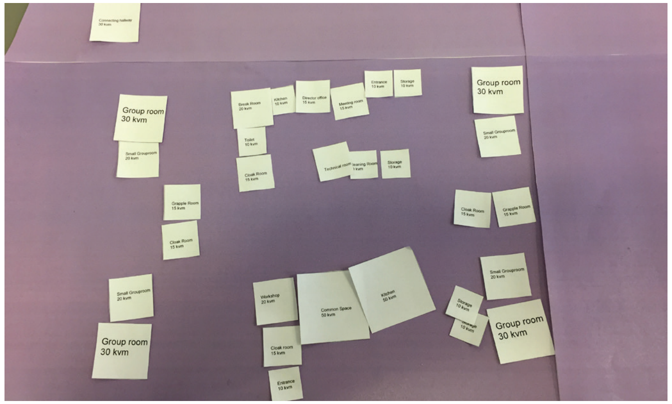
Ill.48: Experimenting with placement of functions



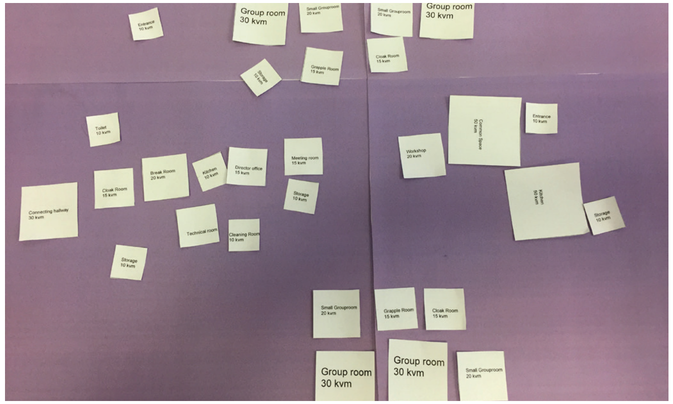
Ill.49: Experimenting with placement of functions



Ill.50: Experimenting with placement of functions



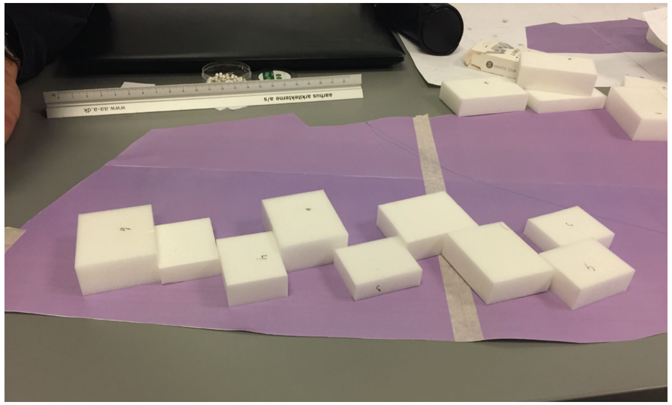
Ill.51: Experimenting with placement of functions

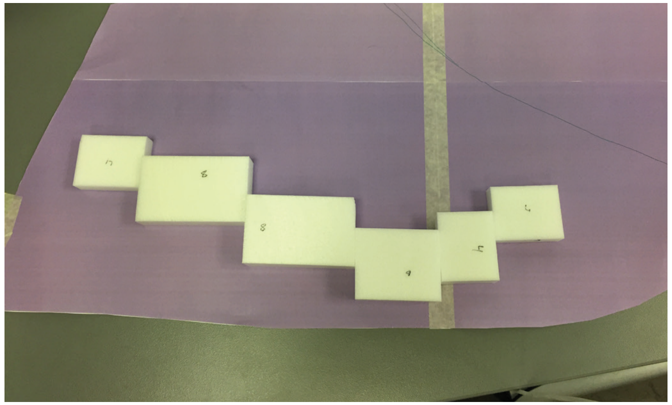


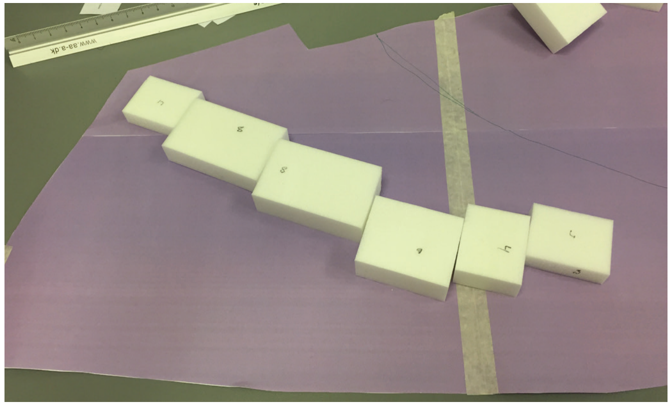
Ill.52: Experimenting with placement of functions

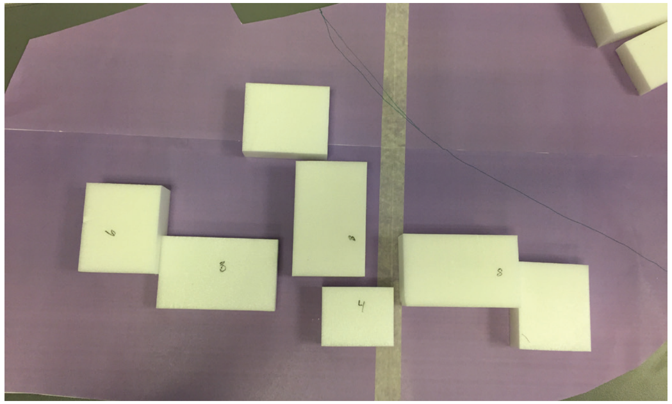
In this phase we have been working on studying the relations between each room in the building. Here different ideas of how they could be connected were tried. Those ideas were based on the tender and the theories from the program phase.

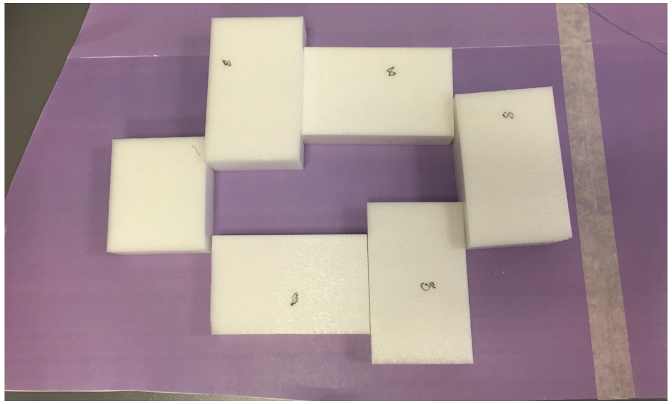
VOLUME STUDIES

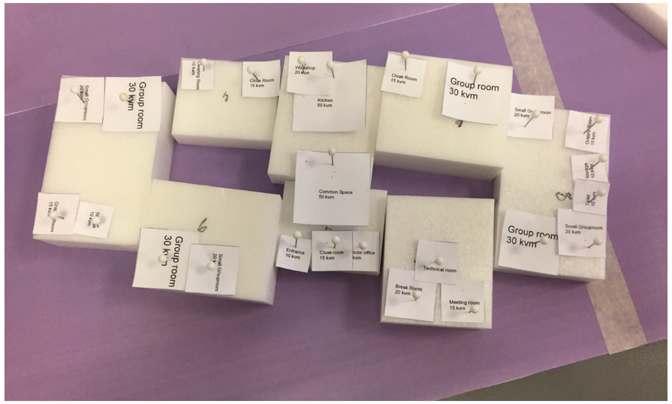

Ill.53: Experimenting with placement of volumes


Ill.54: Experimenting with placement of volumes


Ill.55: Experimenting with placement of volumes


Ill.56: Experimenting with placement of volumes

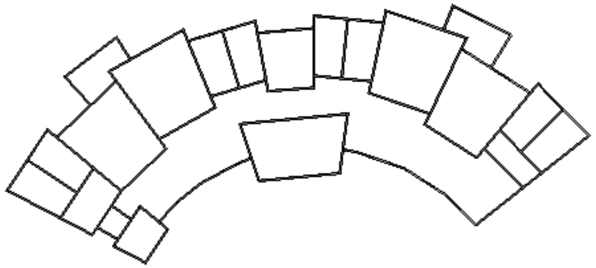

Ill.57: Experimenting with placement of volumes



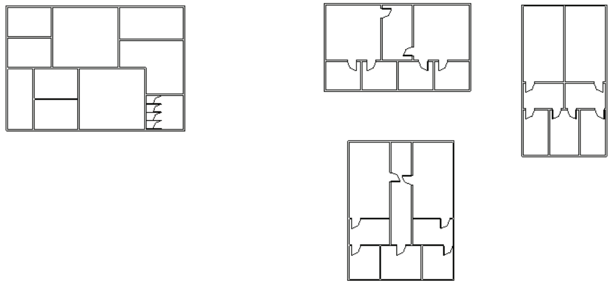
Ill.58: Experimenting with placement of volumes

In the third phase, we did volume studies and worked further with the previous steps. The relations between the rooms were combined, and from it, volumes were created and studied so to investigate if the plans also worked in 3D. In this phase, we were also aware of the site conditions such as the wind and the noise from the roads next to the site and took them into consideration when placing the different volumes.

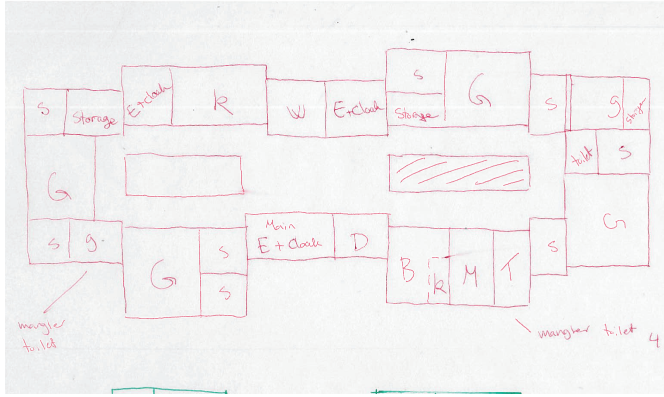
PLAN SOLUTIONS



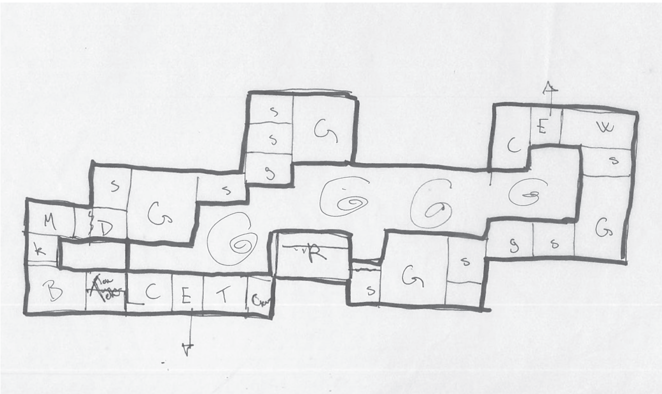
Ill.59: Half circular plan



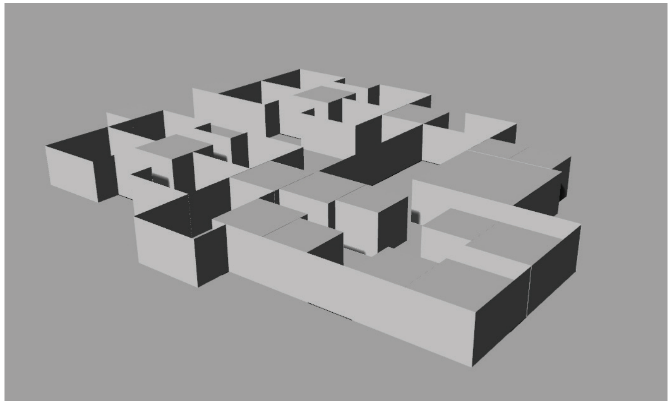
Ill.60: Plan ideas



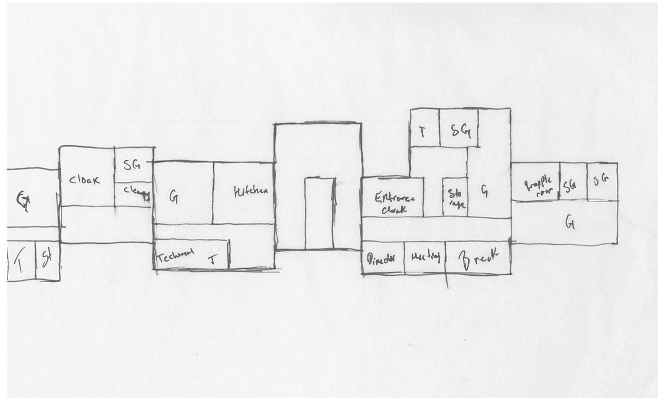
Ill.61: Rectangular plan



Ill.62: Displacemnet between the volumes



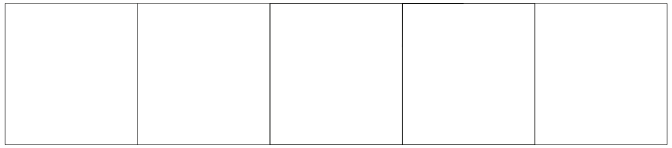
Ill.63: Seperation with function in focus



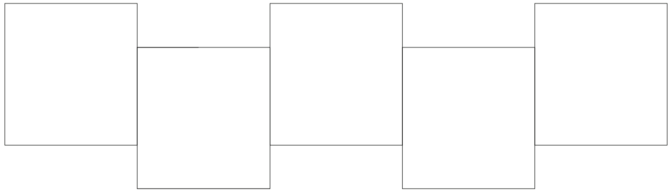
Ill.64: Displaced volumes in plan

In the fourth phase, the relationship studies from the last phase were used to create ideas for different plan drawings. Furthermore, we also took the different technical problematics into considerations, such as sun, wind, natural light, and noise. Things such as the placement of the air handling unit were also discussed in this phase for ensuring the most optimal placement of it.
We used these technical considerations for guiding our design decisions. One of the ways we used this was when we were placing the technical room and ended up placing it in the middle of the building because of our wish of a centralized unit. Another time we used the technical considerations for guiding our design for the windows regarding the daylight factor and the indoor climate.

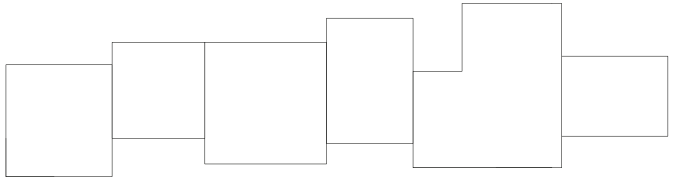
FINAL PLAN SOLUTION



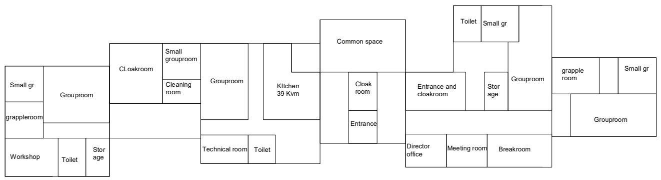
Ill.65: Strict volumes placed in the plan



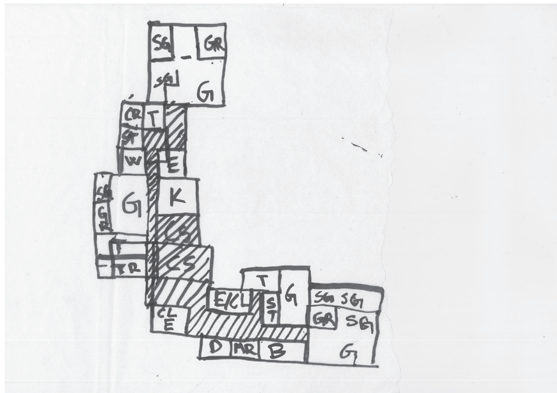
Ill.66: The cubes are displaced in the plan



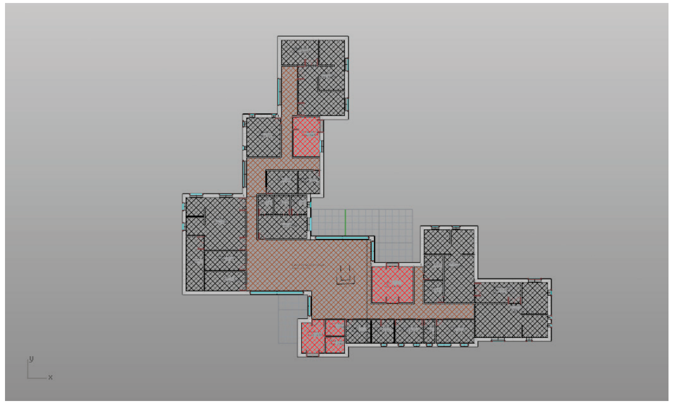
Ill.67: The varying in size



Ill.68: The functions is placed in the plan



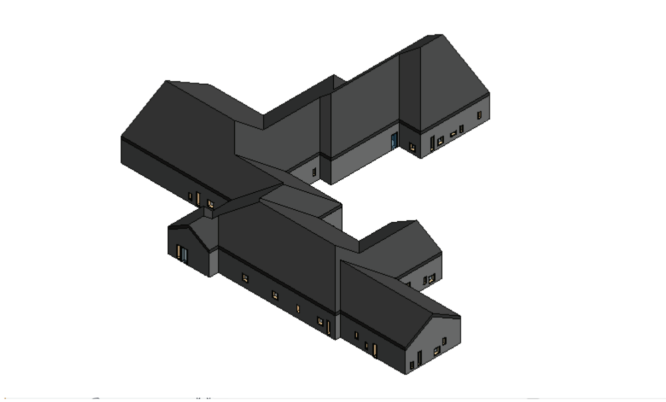
Ill.69: Plan grabs the site due to wind and noise

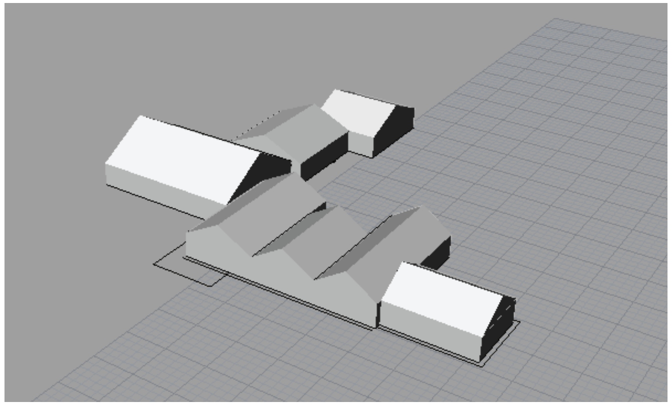


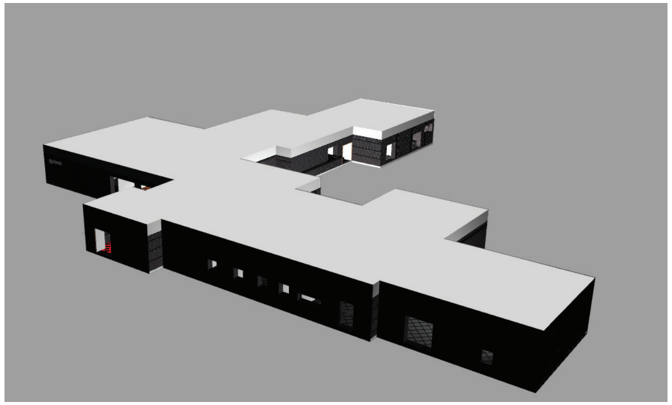
Ill.70: Readjusting the plan according to square meter

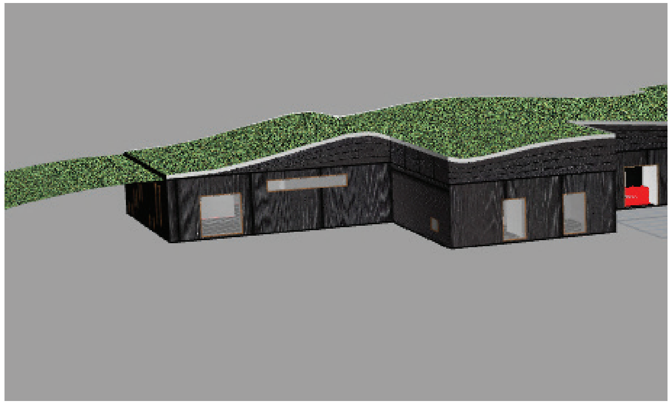
In the fifth phase, we primarily worked with five volumes which we displaced from each other to make some variation between them. From there on the technical aspects such as daylight, indoor climate, noise, and ventilation were taken into consideration.
Here we looked at the importance of shielding for the noise from the road in the south and southeast and at the same time shielding from the wind from the west. In this phase, we also worked on improving the plan solution, where one major problem was that the floor area, in the beginning, were 150 more than what we wanted according to the tender. Another element that was worked on in this phase was the southern wall of the building. Here we discussed what the form of the building should express and how it should be shaped. Furthermore, the functions were also readjusted to obtain more natural light in the areas where people stays for a longer period of time.

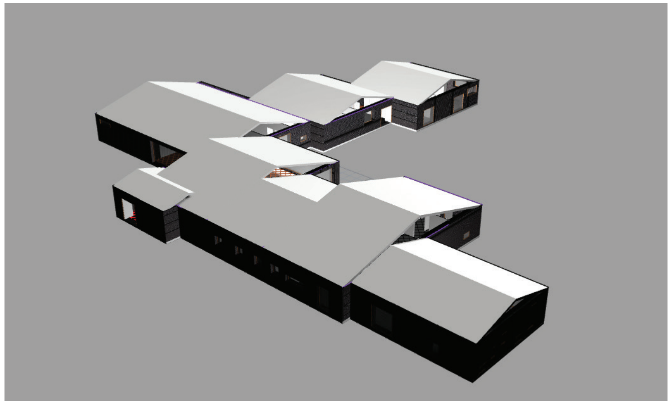
ROOF SHAPES

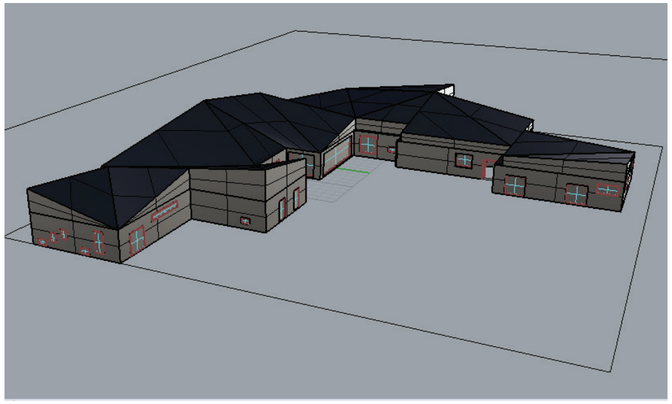

Ill.71: Pitched roof


Ill.72: Pitched roof with different directions


Ill.73: Flat roof

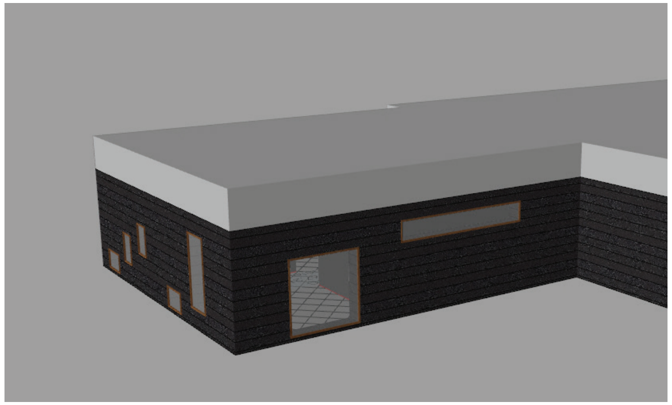

Ill.74: Roof connected with the context

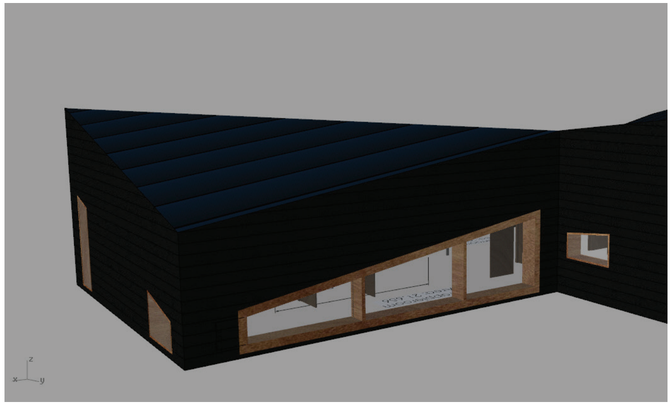

Ill.75: Pitched roof facing south

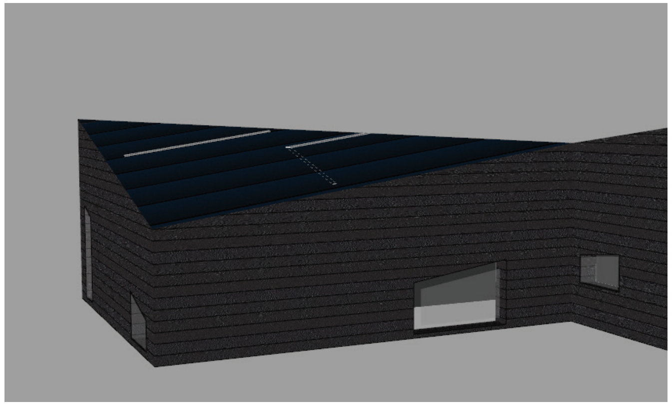

Ill.76: Prismatic roof

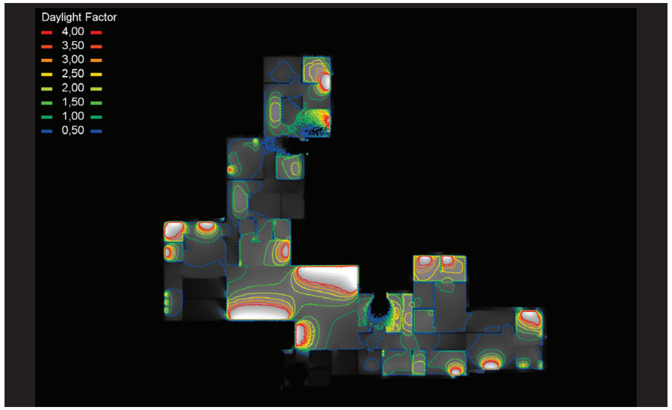
Until this phase, the building had some variation in the plan but still seemed simple when seen from three-dimensions. This is why we in this phase worked with different types of roof. Here we experimented and worked with pros and cons, depending on different types of roofs and shapes and how it would or would not fit into the surrounding context.

WINDOWS

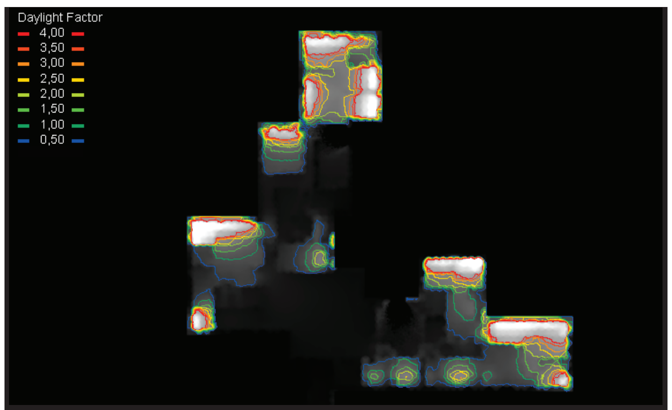

Ill.77: Many different sized square windows


Ill.78: Big windows following shap of the roof

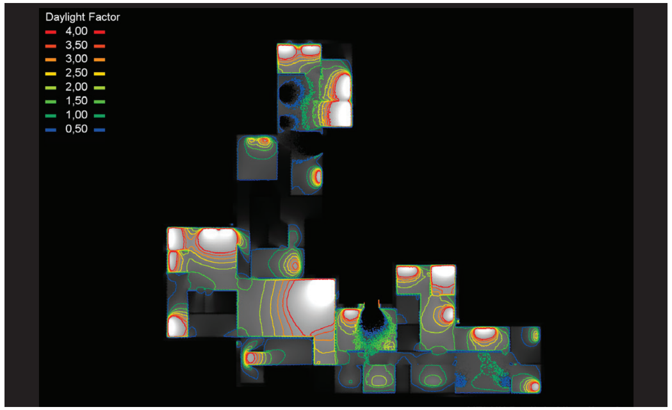

Ill.79: Smaller windows following shape of the roof



Ill.80: Calculating daylight factor



Ill.81: Calculating daylight factor

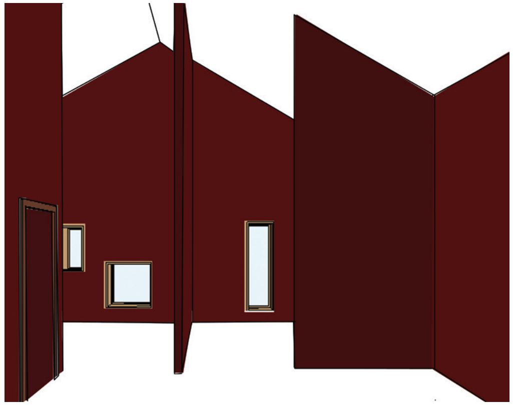


Ill.82: Calculating daylight factor

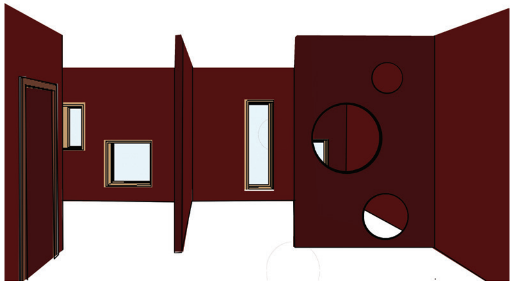
In this phase, we experimented with the windows. Here we worked with different types of window shapes, and the amount of glazing. We also worked with how skylight could influence our design.

It was important for us to achieve enough daylight in the group rooms, but at the same time, the indoor climate should also be satisfying for ensuring that both requirements were met. To ensure this, we have been working with Rhino as 3D modeling software in combination with Velux for calculating the daylight for each design proposal, and at the same time, Bsim has been used for calculating the indoor climate.

THE INTERIOR

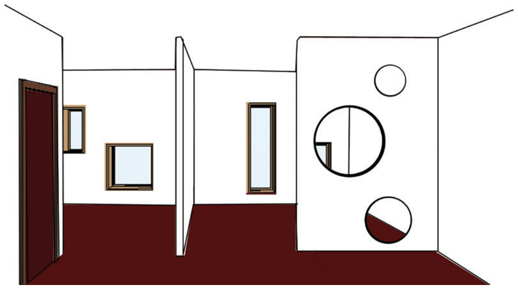


Ill.83: Ceiling following the angels of the roof

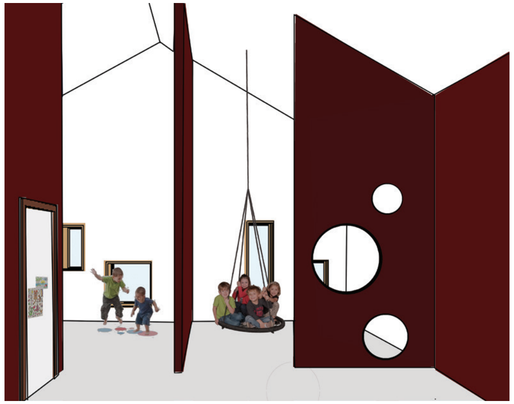


Ill.84: Flat ceiling

Ill.85: Working with the colors of the room



Ill.86: Working with colors of the floor

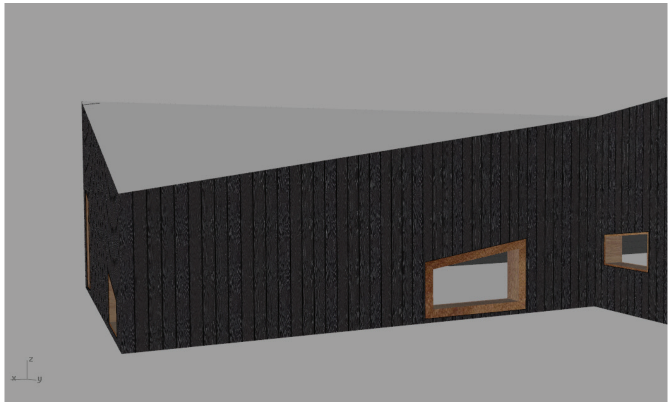


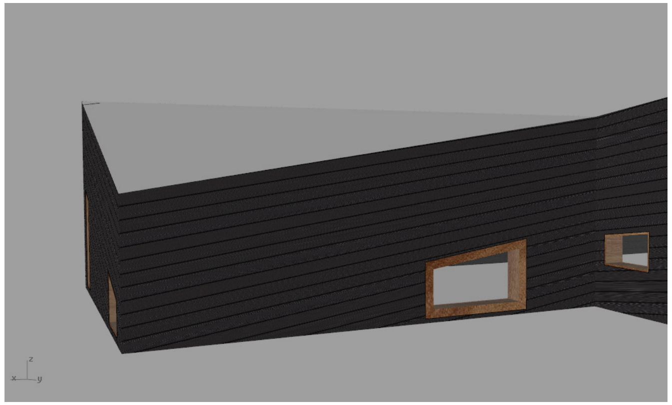
Ill.87: Designing the inner walls

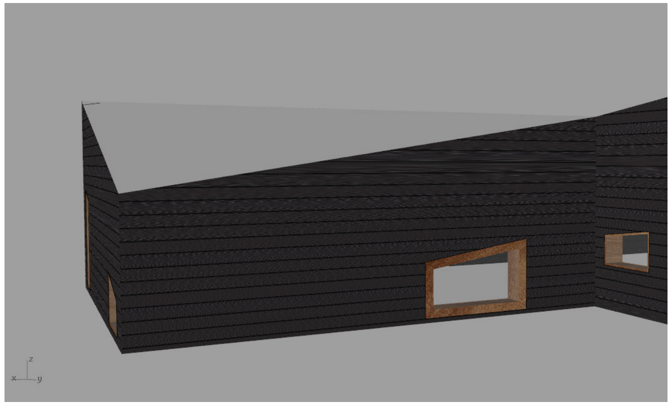
Ill.88: Designing the inner walls

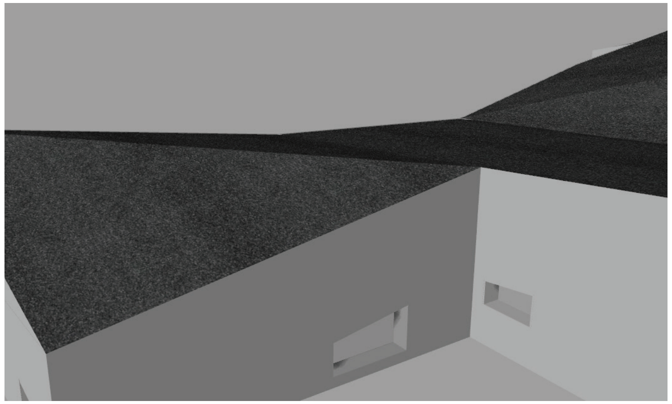
It has been important for us to work further with the interior of the building in this phase. Here we have been experimenting with both having a flat ceiling and letting the ceiling follow the angles of the roof. In this same step, we have also worked with having the ventilation system hidden over the ceiling or showing it inside the rooms and how this would affect the look and feel of the room.
The windows from the outside have been seen from the inside so to see if they also worked in another perspective and here we also worked with how they could be used by the children as a nook they could sit in.

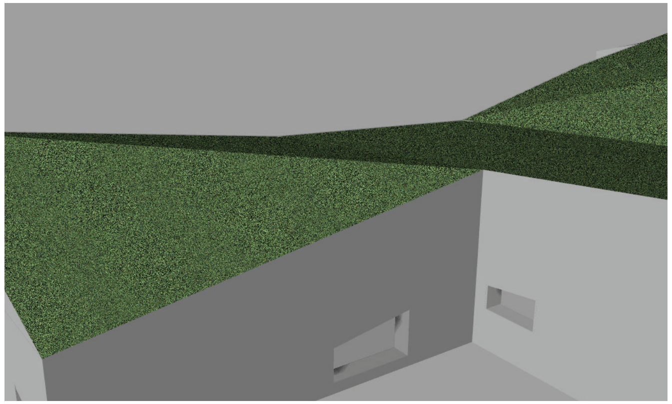
MATERIALS

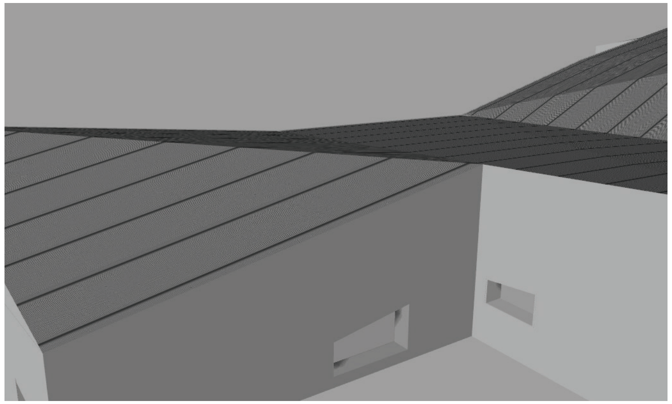

Ill.89: Vertical cladding


Ill.90: Angular cladding


Ill.91: Horizontal cladding


Ill.92: Asphalt roof


Ill.93: Sedum green roof

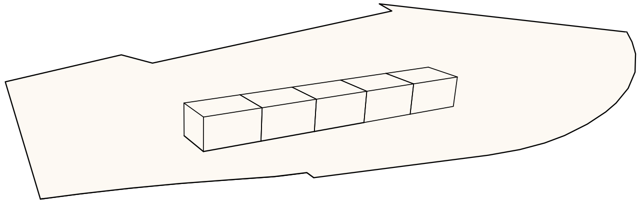

Ill.94: Zink roof

In this phase, the materials were finalized. Here there was a focus on sustainability, acoustical and indoor climate by working and with pachyderm for analyzing the acoustics in one of the group rooms and by looking at the pros and cons of each material regarding their sustainable properties.

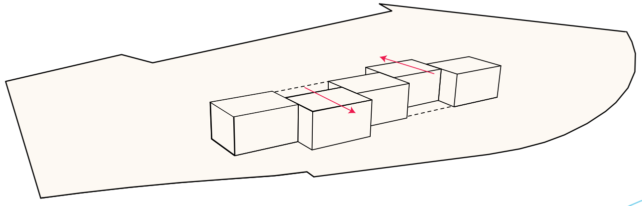
Furthermore, we also worked with how the cladding on the facade should be directed and how it would affect the overall expression of the building. Additionally, we also experimented with the materiality of the roof. When working with the materiality of the roof it was also important to realize that the people from apartments around Kildeparken would be able to see the building from a top perspective.

PRESENTATION

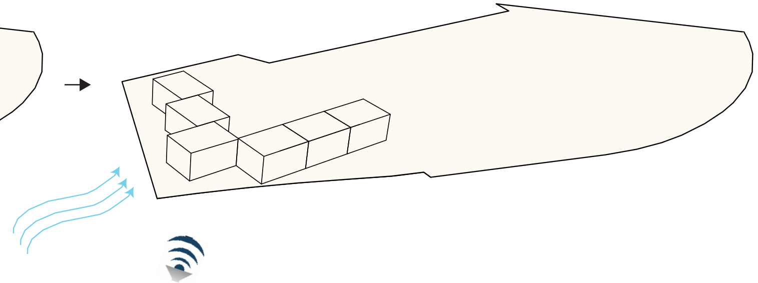
CONCEPT DIAGRAMS



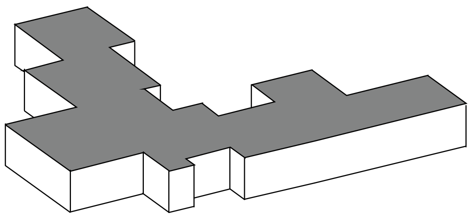
Ill.95: Cubes on a straight line



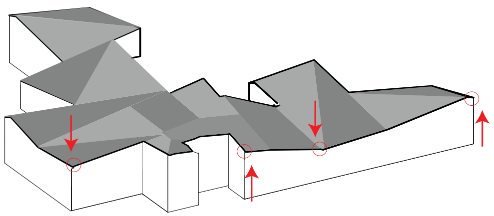
Ill.96: The cubes are displaced



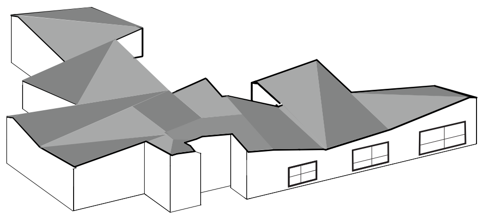
Ill.97: The cubes are placed to grab the site in order to avoid wind and noise and pushed to the edge of the site



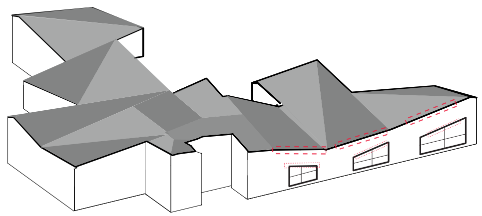
Ill.98: Flat roof



Ill.99: Points of the roof are extruded in different heights to create a prismatic roof based on the interior rooms



Ill.100: Rectangular windows



Ill.101: Windows following the angle of the roof

Ill.103: Siteplan with context 1-1000

THE SITE

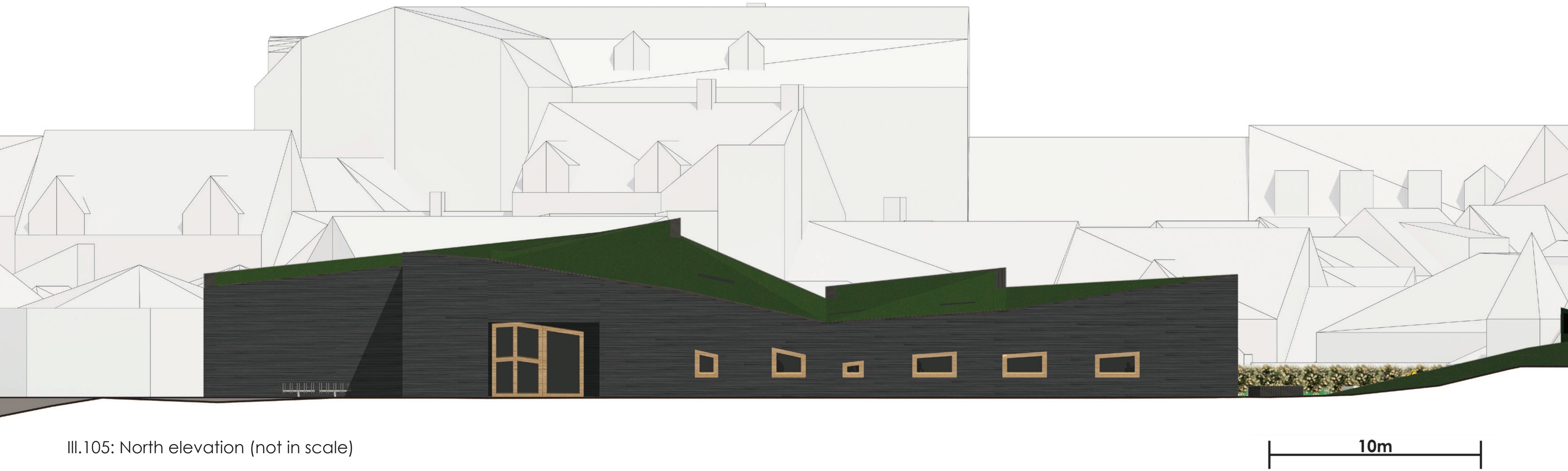
The building is located in the west part of the site so to make a barrier from the wind and the noise coming from the south and the west. There are three ways to enter the site, two of them connected to Karolinelund, the last one is connected to the southern road. The path from Karolinelund is continued into the site and is curved towards the building. In the northern section there have been placed flowers beds and between the paths, the green spaces used for sports activities and play are located. The building is a shielding element for the site to keep wind and noise from the nearby roads away, furthermore, there have been created hills towards the southern part of the site so to work as a shielding element for the playground. In the southeast part of the site, the shed has been placed so to store bikes and playthings to be used in the outdoors areas. In the middle of the site an overhang area is placed, which can be used on rainy days, or for shade in the summer, in addition, the roof on the shed and the overhang is used for solar cells.

Ill.104: Visualization of the playground and Kindergarten

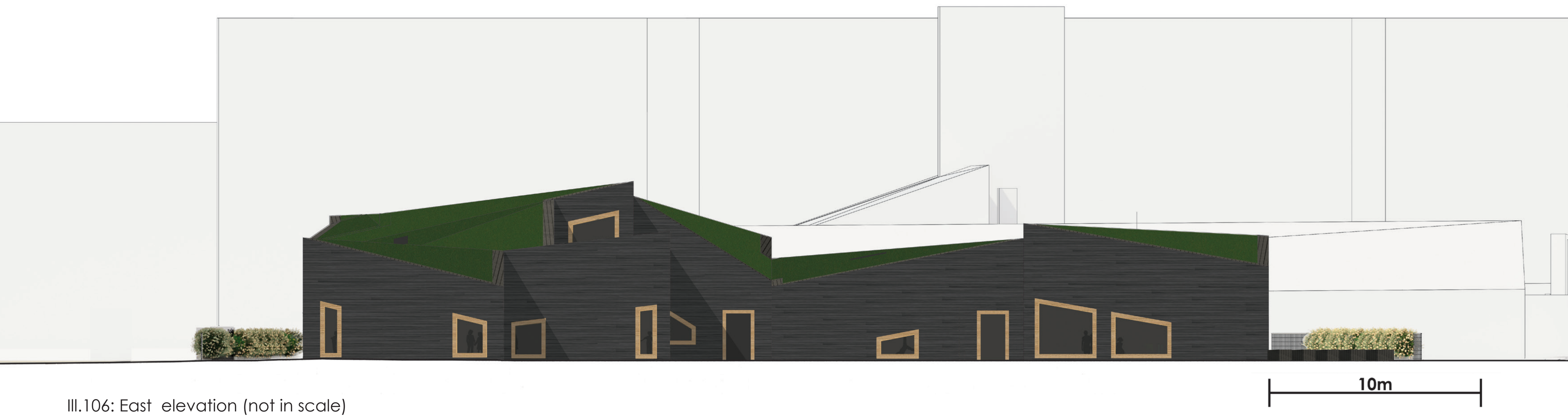
THE FACADE

The roof on the building has a dynamic prismatic shape and because of the different heights, it gives the building a dynamic expression. The height on all of these shapes is based on what function lies underneath it inside the building. When standing next to the building and seeing it a bit from afar it is possible to see part of the green roof. These peaks through to the roof changes depending on from what angles the building gets viewed from.

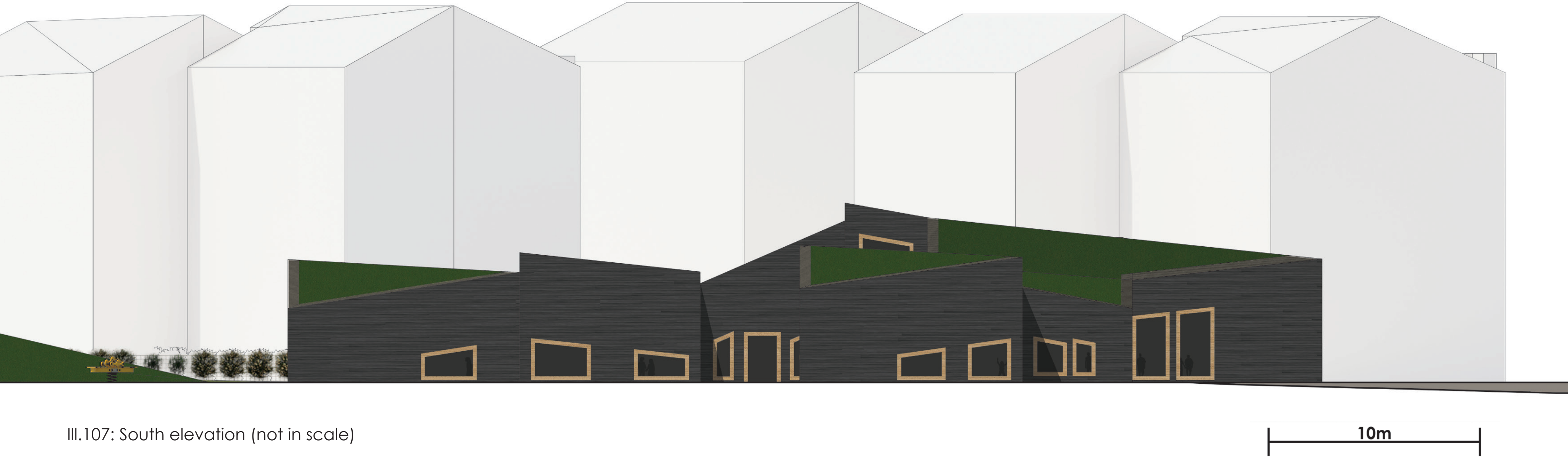
All of the windows in the building follow the angle of the edge of the roof. This means that the windows are all different and helps give the facade a more playful look.



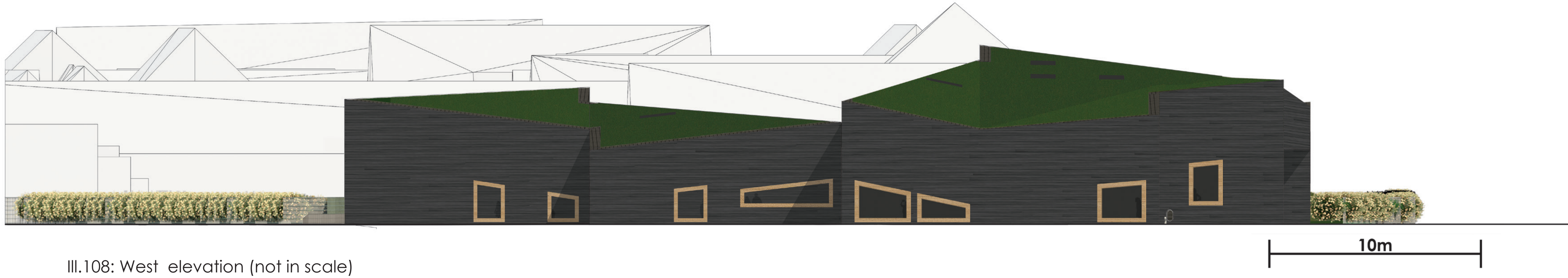
Ill.105: North elevation (not in scale)



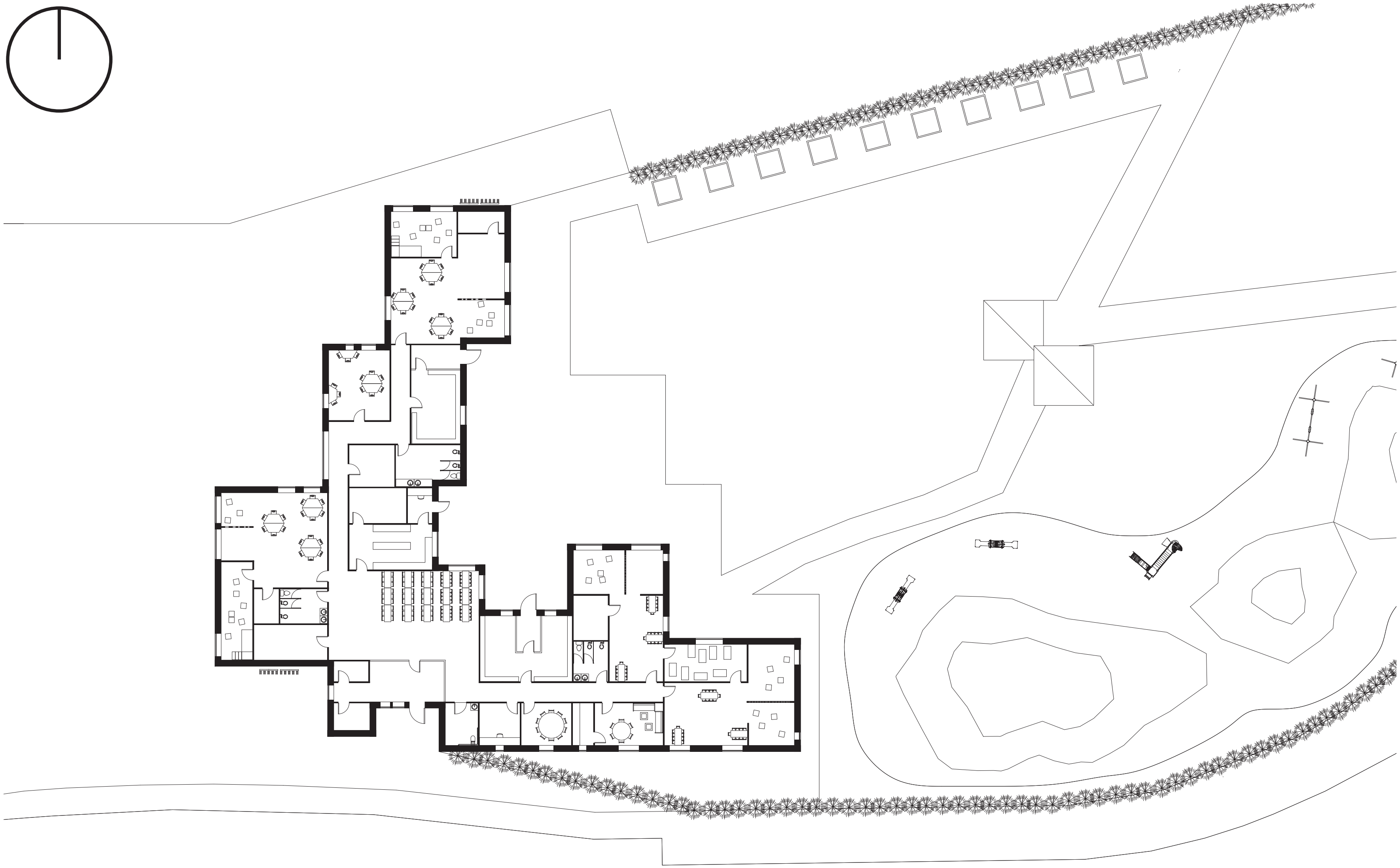
Ill.106: East elevation (not in scale)



Ill.107: South elevation (not in scale)



Ill.108: West elevation (not in scale)



Ill.109: Plan drawing with site 1-500

THE PLAN

The kindergarten has three entrances. Two are located near the group rooms, whereas the main entrance is located towards the south close to the major road. This entrance is mainly used by the staff, and people from the outside, meanwhile the two other entrances is used by the children and their parents, due to their location close to the group rooms, and their direct connection to the cloakrooms.

The main entrance is placed in the south and is connecting straight to the common space, The commonspace is placed in the middle of the building because it functions as the heart of the building and is used to gather the children for lunch and later in the afternoon when there are fewer children.
The technical room with the air handling unit is also placed in the middle of the building because it is a centralized unit and this placement allows it to distribute the air out into both "arms" of the building.
The administration can be found in the southern area.

The group rooms are divided into two different sections. Each section contains two group rooms, the children are separated between those two sections depending on their age. Each group room has a different color to define it. The group rooms towards the southeast section are primarily for the younger children between 3-4 years, those group rooms have a shared grapple room, which is also used for napping.
The group rooms towards the north and the west are for the older children between 5-6 years, where they have separated grapple rooms. Between the group rooms for the older children, there is a workshop which can be used by those children.

The windows are used as an element, where the children can sit. This is done through the elevation of the windows, which are placed lower than usual. Furthermore, the inner walls have been used to divide the group rooms and small group rooms from each other so that the walls aren't fully closed, and this way the children, have several options to separate them self and play in smaller groups. These walls are also clad in Troldtekt and painted in the color of the group rooms so to help the acoustics in the rooms. There are also openings in the wall in different shapes to activate the children's sensory experience, which has also been activated through showing how the ceiling follow the roofs, angels, and the upper edge of the windows also follows the angels of the roof.

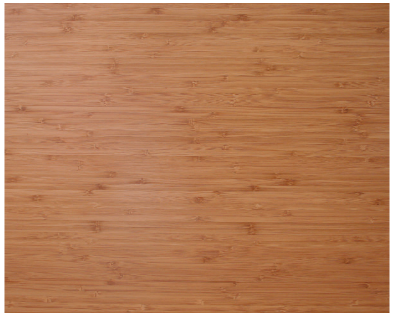
Ill.110: Plan drawing (not in scale)

1	Group room Red	37 m^2
2	Small Group room Red 1	14 m^2
3	Small Group room Red 2	19 m^2
4	Group room Green	33 m^2
5	Small Group room Green 1	12 m^2
6	Small Group room Green 2	16 m^2
7	Grapple room	22 m^2
8	Storage	11 m^2
9	Group room Blue	49 m^2
10	Small Group room Blue1	8 m^2
11	Small Group room Blue 2	8 m^2
12	Grapple room	22 m^2
13	Storage	6 m^2
14	Group room Red	40 m^2
15	Small Group room Red 1	21 m^2
16	Small Group room Red 2	13 m^2
17	Grapple room	21 m^2
18	Storage	7 m^2
19	Workshop	31 m^2
20	Cloakroom East	35 m^2

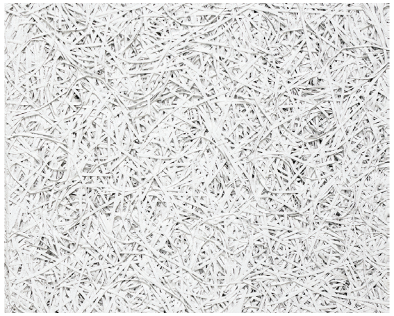
21	Entrance East	6 m^2
22	Cloak room North	25 m^2
23	Entrance North	8 m^2
24	Main Entrance	26 m^2
25	Cloak room 1	5 m^2
26	Cloak room 2	7 m^2
27	Break room	20 m^2
28	Staff kitchen	6 m^2
29	Meeting room	15 m^2
30	Director office	12 m^2
31	Disabled toilet	10 m^2
32	Toilet	10m^2
33	Toilet	11 m^2
34	Toilet	16 m^2
35	Kitchen	26 m^2
36	Office	6 m^2
37	Storage	14 m^2
38	Cleaning room	13 m^2
39	Technical room	18 m^2
40	Commonspace	104 m^2
In total		848 m^2

Ill.111: Room Program

THE MATERIALS


Ill.112: Bamboo floring


Ill.113: Gypsum wall


Ill.114: Troldtek ceiling


Ill.115: Thermowood facade cladding


Ill.116: Sedum roof

Materials have an impact on how the rooms are experienced. In a kindergarten, the user group is primarily children, which needs to be taken into consideration when choosing the materials. Due to this, there has been chosen bamboos flooring, with thick varnish. The material is sustainable, and the thick varnish ensures that it is easier to maintain. The inner walls are made of gypsum, wherein the group rooms some of the walls are colored. The outer walls are made in a timber structure, where the facade is clad with black Thermowood, which is chosen for its sustainability, and its long lifespan. As a contrast to the black stained Thermowood, the window frames are made out of unstained Thermowood. The ceiling is made out of white Troldtekt. This material has several advantages such as improving the acoustical experience in the room, the product is produced by natural materials, and it is possible to get it in several colors. The roof is a Sedum roof which helps slow down the speed to which the rainwater reached the ground so the help with flooding.

THE INTERIOR

The windows in the kindergarten are used as an element, where the children can sit. This is done through the elevation of the windows, which are placed lower than usual. Furthermore, the inner walls have been used to divide the group rooms and small group rooms from each other so that the walls aren't fully closed, and this way the children, have several options to separate them self and play in smaller groups. These walls are also clad in Troldtekt and painted in the color of the group rooms so to help the acoustics in the rooms. Furthermore, there are openings in the wall in different shapes to activate the children's sensory experience, which has also been activated through showing how the ceiling follow the roofs, angels, and the upper edge of the windows also follows the angels of the roof.

The two grapple rooms that are directly connected to the blue and orange group rooms are meant as a place where the children can be physically active indoors. Here the slide and foam board on the walls are integrated into the room.

To reach a good indoor environment it is important not to have too many overheating hours and not to have a too high level of CO_2. This has been studied in four of the rooms in Bsim. Here it was found that the final version of the building design have less than the 25 hours over 27 degrees a year and 100 hours over 26 degrees a year that the building regulations describes (see Appendix 7).

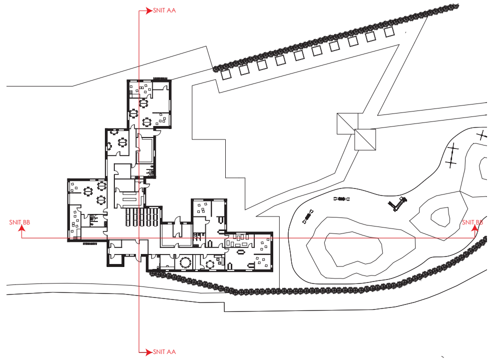
Another thing that is important when trying to reach a good indoor climate is to ensure that the daylight factor isn't too low in the rooms and to create an even distribution of the light in the rooms. The analysis has been done for the whole building, where the focus has been centered around the group rooms. The goal was to reach approximate 3%, which has been reached (see Appendix 8). The software used for making this analysis is the Velux Daylight Visualizer.

But the 3% doesn't say anything about how the light is experienced in the rooms. Therefore there has been placed skylights in the hallways, so to give them some natural light that they otherwise wouldn't get, and in the commonspace, because it otherwise would get most of its natural light from the north.

Part of the floor in the hallway is made out of glass with a compartment underneath. Here the staff and children can make exhibitions instead of putting them in a bookcase that takes up floor space. By putting the exhibitions into the floor it activates the children when then pass through the hallways. (See Ill 120)

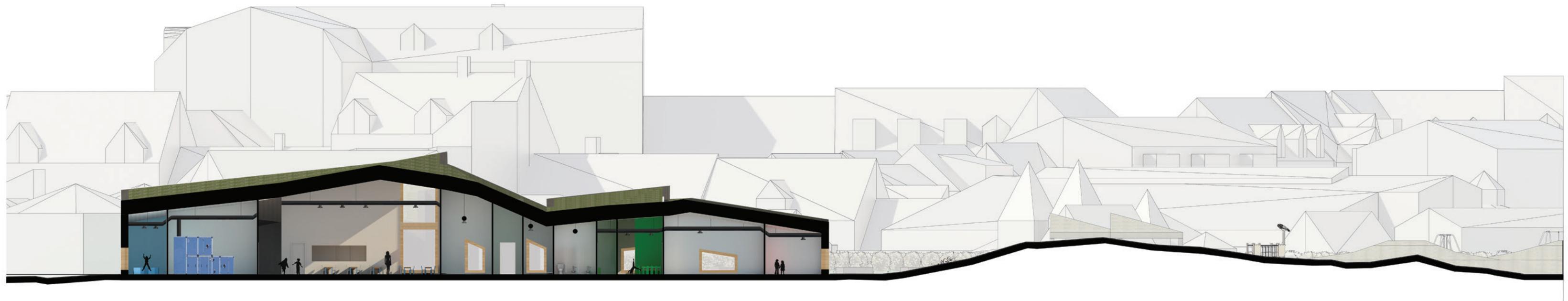
All of the ceilings in the building follows the angles of the roof. This makes the rooms more interesting to look at. Because of the ceiling following the roof it has been chosen to have a visible ventilation duct system. (See Ill 117-120)

Calculating the energy usage of the building, Be15 have been used as a tool. The requirement was set early in the program phase and have been met as the diagrams in Appendix 9 shows. There have been worked with adjusting the building to meet the 2020 requirement, and afterward reach zero energy standards, which has been done through the use of solar panels. The solar panels have been placed at a 30-degree angle and placed on top of the overhang area in the middle of the site, and on top of the shed. The total area of the solar cells spans over 88 m2.



Ill.119: Plan with section (not in scale)

Ill.117: Section AA 1-500



Ill.118: Section BB 1-500

Ill.120: Visualization of the east hallway

Ill.121: Visualization of the commenspace

Ill.122: Visualization of the grapple room

Ill.123: Visualization of the red group room

Ill.124: Visualization of the blue group room

CONCLUSION

The vision for the design of the sustainable kindergarten in Karolinelund has been to create a building which contributes to the activation of the children's sensory experience through the architecture. This has been done in several ways. For example through the materials, colors, shapes of the building and through different geometries in the roof. Furthermore, it opens up for possibilities regarding the differences between the children, through dividing the group room into smaller sections.

On top of creating possibilities for the children, the other focus has been to create a good working environment for the staff by giving them the possibility of having a visual contact towards the children and having easy access to different areas in the building.

To meet the technical requirements, it was necessary to go through several processes of the design. Here, each process was valued and discussed both from the technical point of view and aesthetically. These requirements have been met by following the BR2020 standards which have also led to a good indoor environment.
The sustainable approach has been implemented through the use of partly passive and active strategies.

REFLECTION

There are several things which works in the project, but there are also things which could be improved if there had been more time.
One of the major things which could be looked even deeper into is how to implement more toys as part of the building, those could be swings, climbing walls etc.

Another thing that could have been looked more into if there would have been more time is the site. Currently, the site is separated into different zones, where it opens up to different activities which can be chosen by the user, but it might be better to separate it further into different functions instead.

One of our criteria's was to work with light. Here we only worked with natural light but never got to experiment with artificial light and how it could frame different zones in the different rooms and how it can be used to activate the children's sensory experiences. This is something that we would have liked to experiment with if there had been more time.

The last thing that could be improved, if there had been more time, would be to reduce the energy frame even further, by implementing passive strategies.

LIST OF ILLUSTRATIONS

Ill 1 - Ill 5: Own illustration

Ill 6: http://www.euro-t-guide.com/See_Photo/Denmark/JUT-N/Karolinelund_Aalborg_2010_18.jpg

Ill 7: Own illustration

Ill 8: http://www.aalborg.dk/media/2976690/karolinelund-scenarie1a.jpg

Ill 9 - Ill 26: Own illustration

Ill 27: http://tinypic.com/view.php?pic=16gaosg&s=9#.WRXvKPnyjIV

Ill 28: http://images.adsttc.com/media/images/56d7/4d51/e58e/ce21/e500/0014/large_jpg/KHB330-23311.jpg?1456950588

Ill 29: http://www.leblogdesptisloulous.com/wp-content/uploads/2011/09/ecole-enfant-design-5.jpg

Ill 30: http://s3.amazonaws.com/europaconcorsi/project_images/4577224/Foyer_50_low_large.jpg

Ill 31 - Ill 111: Own illustration

Ill 112: http://www.borninazoo.com/thumbnail/lovely-simple-decorating-ideas-for-living-room-13-download-free-wood-textures-texturex-bamboo-pattern-plank-floor.jpg

Ill 1113: http://www.dfb.com.pk/assets/images/galleryproduct/gypsum-pearl.jpg

Ill 1114: http://www.creativecave.dk/images/pic/standard_produkt/81.jpg

Ill 1115: http://www.thermowood.ca/wp-content/uploads/2013/12/0231-150x150.jpg

Ill 1116: http://assets.inhabitat.com/files/ford-green-roof-1.jpg

Ill 1117 - Ill 127: Own illustration

Ill 128: https://itsolution.lindab.com/lindabwebproductsdoc/pdf/documentation/comfort/dk/technical/lca.pdf

Ill 129: https://itsolution.lindab.com/lindabwebproductsdoc/pdf/documentation/comfort/dk/technical/lca.pdf

Ill 128 - Ill 159: Own illustration

LIST OF REFERENCES

Albæk Nielsen, A. & Nygaard Christoffersen, M. (2009). Børnehavens betydning for børns udvikling (1st ed., pp. 68-78). København: SFI--Det Nationale forskningscenter for velfærd.

Andersen, P., & Kampmann, J. (1996). Børns legekultur (1st ed.). København: Gyldendal Uddannelse.

Byens Netværk: Solhuset - bæredygtighed i sol- og børnehøjde - Dansk Arkitektur Center. Dac.dk. Retrieved 24 February 2017, from http://www.dac.dk/22824.aspx

Byvejr: DMI. (2017). Dmi.dk. Retrieved 8 February 2017, from http://www.dmi.dk/vejr/til-lands/byvejr/

Bygningsreglementet.dk. Retrieved 13 February 2017, from http://bygningsreglementet.dk/br10_04_id5183/0/42

Conick-Smith, N. (2011). Barndom og arkitektur (1st ed.). Aarhus: Klim.

Gammelby, M. (2013). Plads til barndommen (1st ed.). Statens Byggeforskningsinstitut, Aalborg Universitet.

Climate Aalborg. (2017). meteoblue. Retrieved 8 February 2017, from https://www.meteoblue.com/en/weather/forecast/modelclimate/aalborg_denmark_

CR 1752. (1998) (1st ed.).

DS 474. (1995) (1st ed.).

Holm, T., Iversen, M., Jensen, C., Kampmann, J., Ryhl, L., & Schwede, H. et al. (2004). Indenfor (1st ed.). Vejle: Kroghs Forlag.

Hyldgård, C. (1997). Grundlæggende klimateknik og bygningsfysik (1st ed.). Aalborg: Aalborg universitet institut for bygningsteknik.

Kampmann, J. (1994). Barnet og det fysiske rum (1st ed.). Kbh.: Forlaget Børn & Unge.

Karolinelund - baggrundsinformation. (2011) (1st ed.). Aalborg.

Karolinelund Helhedsplan marts 2015. (2015) (1st ed.). Aalborg.

Kirkeby, I., Gammelby, M., & Dyhring Elle, S. (2013). SBI 2013:11 - Plads til trivsel og udvikling (1st ed.)

Kjærgård, H., Støvring, B., & Tromborg, A. (2012). Barnets lærende hjerne (1st ed.). Frydenlund.

Knudstrup, M. (2004). Integrated Design Process in Problem-Based Learning (1st ed.). Aalborg: Aalborg Universitetsforlag.

Kural, R., Bruun Jensen, B., & Kirkeby, I. (2010). Apropos - arkitektur, pædagogik og sundhed (1st ed.). København: Kunstakademiets Arkitektskole.

Lokalplan 1-1-124. (2016) (1st ed.). Aalborg.

Marsh, R. (2006). Arkitektur og energi (1st ed.). Hørsholm: Statens Byggeforskningsinstitut.

Marsh, R. (2017). arkitektur og energi: mod en 2020-lavenergistrategi (1st ed.). Hørsholm: statens byggeforskningsinstitut.

Marsh, R., & Lauring, M. (2006). Bolig. Miljø. Kvalitet (1st ed.). Hørsholm: Statens Byggeforskningsinstitut.

Marthagården. Lendager Group. Retrieved 25 February 2017, from https://lendager.com/arkitektur/marthagarden/#kontekst

Maxmilling, H., Kristensen, T., & Piilgaard Hansen, H. (2016). Motorisk fysik aktivitet og stillesiddende tid hos 0-6 årige børn (1st ed.). Sundhedsstyrelsen.

Your Bibliography: McLachlan, F. (2012). Architectural colour in the professional palette (1st ed.). Abingdon, Oxon [England]: Routledge.

Miljøgis. (2017). Miljoegis.mim.dk. Retrieved 6 February 2017, from http://miljoegis.mim.dk/spatialmap?&profile=noise

Parigi, Dario (2015). Performance Aided Design [PowerPoint slides]. Retrieved from https://www.moodle.aau.dk/pluginfile.php/465605/mod_folder/content/0/ acoustic%20parameters%20(2).pdf?forcedownload=1

Parkerings- og færdselsarealer. Parkerings- og færdselsarealer. Retrieved 9 April 2017, from http://www.hfb.dk/fileadmin/templates/hfb/dokumenter/rum-pdf/14_Parkeringsarealer.pdf

Ringsmose, C., & Staffeldt, S. (2012). Rum og læring (1st ed.). Frederikshavn: Dafolo.

Solhuset. Solhuset.horsholm.dk. Retrieved 25 February 2017, from http://solhuset.horsholm.dk/FrontEnd.aspx?id=72212

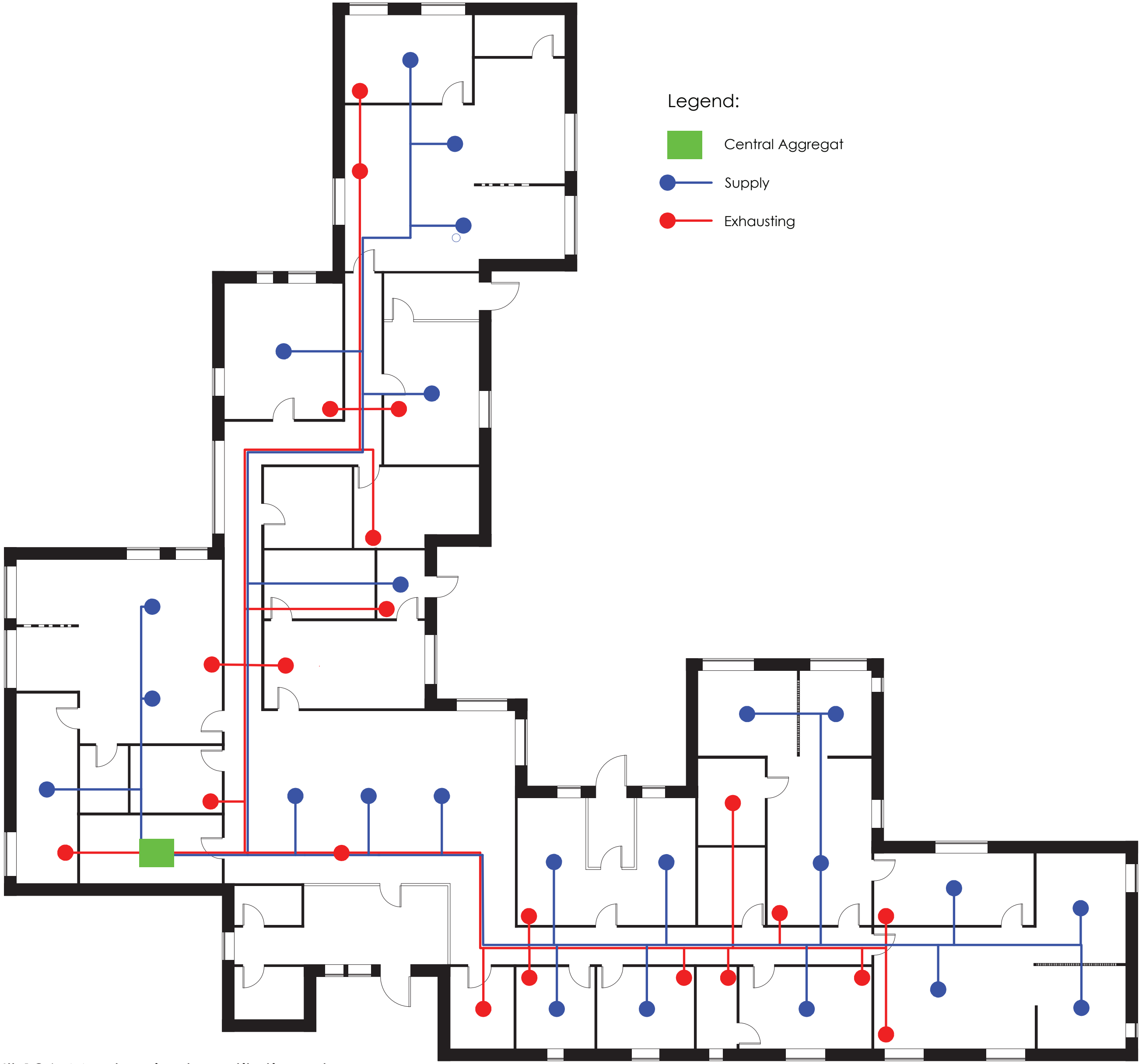

Friis

APPENDIX

APPENDIX 1: EMERGENCY ESCAPE PLAN

Ill.125: Emergency escape plan

APPENDIX 2: MECHANICAL VENTILATION



Ill.126: Mechanical ventilation plan

APPENDIX 3: VENTILATION CALCULATIONS

The necessary airflow is calculated to obtain a good air quality. Below a calculation are showed as an example of one of the group rooms.

Information:
Area of the apartment: 48.90 m^2
Height of the apartment: 4.2 m.
Pollution from persons: 1.2 kids in kindergarten
Pollution from building/materials: 0.4 olf each square meter (TABLE A.8, CR1752)

Formula for calculating the necessary airflow:

$$c = c_i + 10 * \frac{q}{V_l}$$

c is the experienced air quality (dp)
c_i is the experienced air quality of the outdoor air (dp)
q is the pollution load (olf)
V_l is the necessary air flow supply (l/s)

Through CR1752, it is possible to find that the experienced air quality must be 1.4 DP (Table A.5, CR1752, 1998), to ensure that maximum 20% of the people will be unsatisfied. The experienced quality of the air outside is c_i = 0.05 (Table 1.7, Hyldgård, 1997).

The total pollution:

$$q = 1.2\, olf * 14\, person + 0.4 \frac{olf}{m^2} * 48.90\, m^2 = 36.36\, olf$$

The necessary airflow:

$$1.4 = 0.05 + 10 * \frac{36.36}{V_l}$$

$$V_l = 269.33\ \frac{l}{s}$$

Air exchange rate:

$$n = \frac{V_l * 3600s}{1000l * V_{rum}} = \frac{269.33\frac{l}{s} * 3600}{1000\ l * 205.38\ m^3} = 4.72\ h^{-1}$$

Table of calculation for the rooms in the apartments.

Sustainable kindergarten karolinelund	Area[m2]	Height [m]	Volume [m3]	Persons	Olf each person	Background pollution
Common Space	197,685	3	593,055	10	1,2	0,4
Group Room N	66	3	199,266	28	1,2	0,4
Grappleroom N	20,9	3	62,7	5	1,2	0,4
Storage N	14,82	3	44,46	1	1,2	0,4
Entrance NE	32,34	3	97,02	5	1,2	0,4
Workshop	29,955	3	89,865	5	1,2	0,4
Cleaning Room	13,332	3	39,996	1	1,2	0,4
Toilet	17,581	3	52,743	2	1,2	0,4
Storage Kitchen	6,719	3	20,157	1	1,2	0,4
Freeze area	7,148	3	21,444	0	1,2	0,4
Kontor	6,088	3	18,264	1	1,2	0,4
Office	26,306	3	78,918	2	1,2	0,4
Group Room V	63,911	3	191,733	28	1,2	0,4
Grappleroom V	21,677	3	65,031	5	1,2	0,4
Storage V	5,944	3	17,832	1	1,2	0,4
Toilet V	11,601	3	34,803	2	1,2	0,4
Technical Room	18,143	3	54,429	0	1,2	0,4
Entrance S	18,301	3	54,903	5	1,2	0,4
Cloak Room 1 S	8,108	3	24,324	3	1,2	0,4
Cloak Room 2 S	8,133	3	24,399	3	1,2	0,4
Toilet South	13,29	3	39,87	2	1,2	0,4
Director office S	12,02	3	36,06	1	1,2	0,4
Meeting Room S	14,865	3	44,595	3	1,2	0,4
Kitchen S	6,18	3	18,54	1	1,2	0,4
Breakroom	20,272	3	60,816	3	1,2	0,4
Entrance N	34,1	3	102,3	5	1,2	0,4
Storage NE GS	9,715	3	29,145	1	1,2	0,4
Toilet NE GS	10,875	3	32,625	1	1,2	0,4
Grouproom NE	60,093	3	180,279	28	1,2	0,4
Grappleroom NE	21,49	3	64,47	5	1,2	0,4

Special needs [L/s]	Total olf	Air flow [l/s]	Air flow [m3/h]	Air change[h-1]	L/s m2
	91,074	827,9454545	2980,603636	5,025846905	4,188205754
	60,1688	546,9890909	1969,160727	9,882070836	8,23505903
	14,36	130,5454545	469,9636364	7,495432797	6,246193997
	7,128	64,8	233,28	5,246963563	4,372469636
	18,936	172,1454545	619,7236364	6,38758644	5,3229887
	17,982	163,4727273	588,5018182	6,548732189	5,457276824
	6,5328	59,38909091	213,8007273	5,345552737	4,454627281
10	9,4324	85,74909091	308,6967273	5,85284734	4,877372784
	3,8876	35,34181818	127,2305455	6,311978244	5,25998187
	2,8592	25,99272727	93,57381818	4,363636364	3,636363636
	3,6352	33,04727273	118,9701818	6,513917095	5,428264246
15	12,9224	117,4763636	422,9149091	5,358915698	4,465763082
	59,1644	537,8581818	1936,289455	10,09888467	8,415737225
	14,6708	133,3709091	480,1352727	7,383175297	6,152646081
	3,5776	32,52363636	117,0850909	6,566010033	5,471675028
10	7,0404	64,00363636	230,4130909	6,620495098	5,517079249
	7,2572	65,97454545	237,5083636	4,363636364	3,636363636
	13,3204	121,0945455	435,9403636	7,940192041	6,616826701
	6,8432	62,21090909	223,9592727	9,20733731	7,672781092
	6,8532	62,30181818	224,2865455	9,192448275	7,660373562
10	7,716	70,14545455	252,5236364	6,333675354	5,278062795
	6,008	54,61818182	196,6254545	5,452730298	4,543941915
	9,546	86,78181818	312,4145455	7,005595817	5,837996514
15	3,672	33,38181818	120,1745455	6,481906443	5,401588703
	11,7088	106,4436364	383,1970909	6,300925594	5,250771328
	19,64	178,5454545	642,7636364	6,2831245	5,235937083
	5,086	46,23636364	166,4509091	5,711130866	4,759275722
10	5,55	50,45454545	181,6363636	5,567398119	4,639498433
	57,6372	523,9745455	1886,308364	10,46327284	8,71939403
	14,596	132,6909091	477,6872727	7,409450484	6,17454207

CO_2:

The air exchange concentration for category B building is found in CR1752. The CO_2 load must maximum be 660 ppm higher than the outdoor concentration, following the category B, which is 350 ppm in Denmark. A child exhales 18 l/h carbon dioxide (TABLE A.6, CR1752, 1998).

Formula used for calculating the CO_2 concentration:

$$c = \frac{q}{nV} + c_i$$

$$q = 18\frac{l}{h} * person$$

$$q = 14 * \left(\frac{18\frac{l}{h}}{1000l} \right) = 0.25\ m^3/h$$

The air change rate formula:

$$C = \frac{q}{n * V} * c_i$$

$$1010\ ppm = \frac{0.45\ m^3/h}{n * 205.38} * 10^6 + 350\ ppm = 3.32\ h^{-1}$$

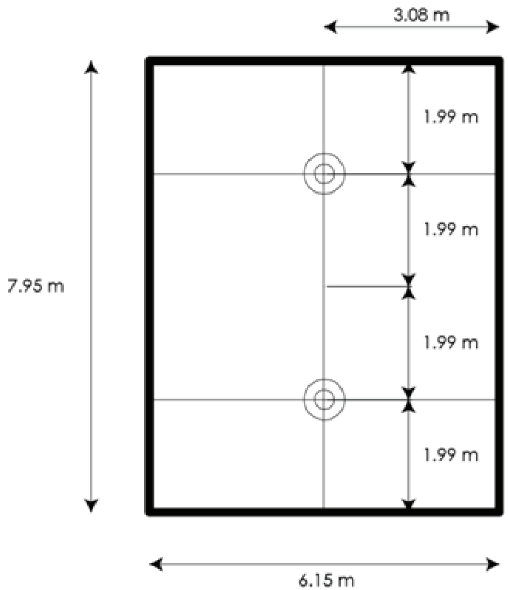
Table of calculation for the rooms in the apartments.

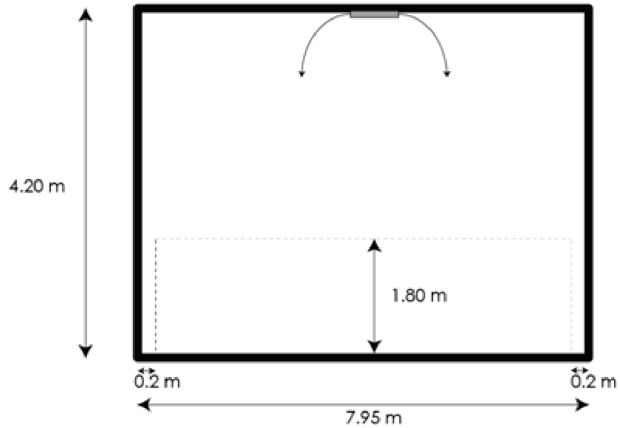
Sustainable kindergarten karolinelund	Area [m2]	Height [m]	Volume [m3]	Persons	Activity level [met]	CO2 q[l/h/person]
Common Space	197,685	3	593,055	10	1,4	18
Group Room N	66	3	199,266	28	1,4	18
Grappleroom N	20,9	3	62,7	5	1,4	18
Storage N	14,82	3	44,46	1	1,4	18
Entrance NE	32,34	3	97,02	5	1,4	18
Workshop	29,955	3	89,865	5	1,4	18
Cleaning Room	13,332	3	39,996	1	1,4	18
Toilet	17,581	3	52,743	2	1,4	18
Storage Kitchen	6,719	3	20,157	1	1,4	18
Freeze area	7,148	3	21,444	0	1,4	18
Office	6,088	3	18,264	1	1,4	18
Kitchen	26,306	3	78,918	2	1,4	18
Group Room V	63,911	3	191,733	28	1,4	18
Grappleroom V	21,677	3	65,031	5	1,4	18
Storage V	5,944	3	17,832	1	1,4	18
Toilet V	11,601	3	34,803	2	1,4	18
Technical Room	18,143	3	54,429	0	1,4	18
Entrance S	18,301	3	54,903	5	1,4	18
Cloak Room 1 S	8,108	3	24,324	3	1,4	18
Cloak Room 2 S	8,133	3	24,399	3	1,4	18
Toilet South	13,29	3	39,87	2	1,4	18
Director office S	12,02	3	36,06	1	1,4	18
Meeting Room S	14,865	3	44,595	3	1,4	18
Kitchen S	6,18	3	18,54	1	1,4	18
Breakroom	20,272	3	60,816	3	1,4	18
Entrance N	34,1	3	102,3	5	1,4	18
Storage NE GS	9,715	3	29,145	1	1,4	18
Toilet NE GS	10,875	3	32,625	1	1,4	18
Grouproom NE	60,093	3	180,279	28	1,4	18
Grappleroom NE	21,49	3	64,47	5	1,4	18
Grouproom S	68,838	3	206,514	28	1,4	18

Total CO2 [l/h]	CO2 load [m^3/h]	Difference [PPM]	nV [m3/h]	Air change n=(h-1)	L/s	L/s m2
252	0,252	660	818,4159	1,38	0,38333333	0,001939112
705,6	0,7056	660	2058,41778	10,33	2,86944444	0,043200211
126	0,126	660	408,804	6,52	1,81111111	0,086656034
25,2	0,0252	660	81,8064	1,84	0,51111111	0,034487929
126	0,126	660	81,4968	0,84	0,23333333	0,007215007
126	0,126	660	408,88575	4,55	1,26388889	0,042192919
25,2	0,0252	660	81,59184	2,04	0,56666667	0,04250425
50,4	0,0504	660	163,5033	3,1	0,86111111	0,048979643
25,2	0,0252	660	163,47327	8,11	2,25277778	0,335284682
0	0	660	0	0	0	0
25,2	0,0252	660	81,82272	4,48	1,24444444	0,204409403
50,4	0,0504	660	82,07472	1,04	0,28888889	0,010981863
705,6	0,7056	660	162,97305	0,85	0,23611111	0,003694374
126	0,126	660	409,04499	6,29	1,74722222	0,080602584
25,2	0,0252	660	81,84888	4,59	1,275	0,214502019
50,4	0,0504	660	163,5741	4,7	1,30555556	0,112538191
0	0	660	0	0	0	0
126	0,126	660	409,02735	7,45	2,06944444	0,113078217
75,6	0,0756	660	245,42916	10,09	2,80277778	0,345680535
75,6	0,0756	660	245,45394	10,06	2,79444444	0,343593317
50,4	0,0504	660	163,467	4,1	1,13888889	0,085695176
25,2	0,0252	660	81,8562	2,27	0,63055556	0,052458865
75,6	0,0756	660	245,2725	5,5	1,52777778	0,102776843
25,2	0,0252	660	81,7614	4,41	1,225	0,198220065
75,6	0,0756	660	245,08848	4,03	1,11944444	0,055221214
126	0,126	660	408,177	3,99	1,10833333	0,032502444
25,2	0,0252	660	81,89745	2,81	0,78055556	0,080345399
25,2	0,0252	660	81,5625	2,5	0,69444444	0,06385696
705,6	0,7056	660	2291,34609	12,71	3,53055556	0,058751528
126	0,126	660	408,7398	6,34	1,76111111	0,081950261
705,6	0,7056	660	2290,24026	11,09	3,08055556	0,0447508

Penetration Depth:

It is important to ensure that the air speed of the supply is below 0.2 m/s when it reach the zone where people are in. Therefor the supply dimension is chosen and the penetration depth is calculated.





Ill.127: Penetration dept

Below the calculation for the penetration depth is done for two supplies attached in the ceiling.

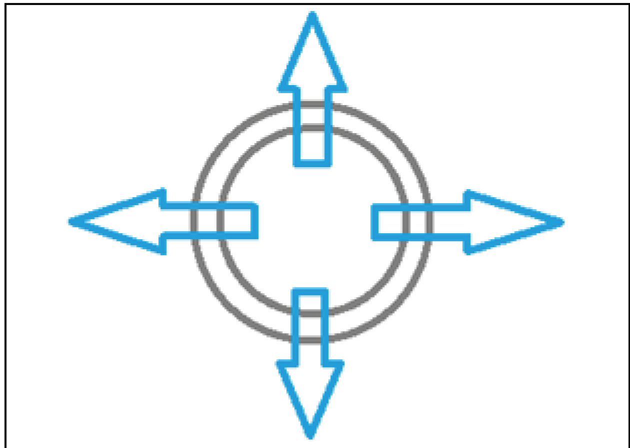
$$\frac{\mathbf{3}}{\mathbf{4}}\,\boldsymbol{x\ length} \quad and \quad \boldsymbol{Length} + \boldsymbol{Height_{difference}}$$

$$0.75 * \left(\frac{1.99m}{2}\right) + (4.2m - 1.8m) = \mathbf{3.95\ m} \qquad og \qquad \left(\frac{1.99m}{2}\right) + (4.2m - 1.8m) = \mathbf{3.14\ m}$$

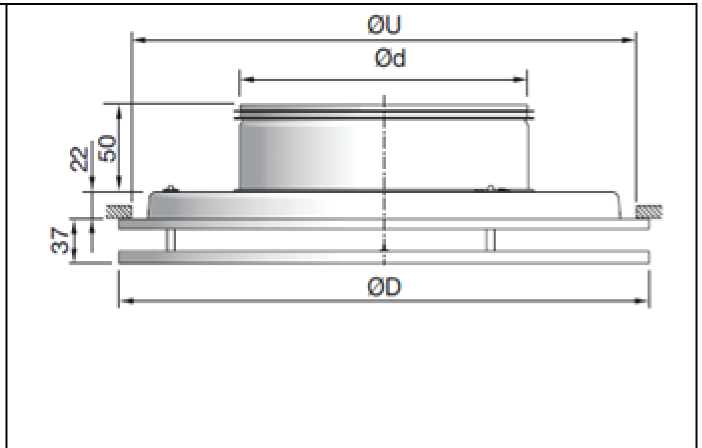
$$l_{02} = [3.14m\,; 3.95m]$$

The necessary airflow for each installation has been calculated to 484.69 m^3/h. The penetration depth has been found research from different products. Where a LCA-315 is chosen, a product from Lindab.

$$\frac{4.72\,h^{-1} * 205.38\,m^3}{2} = 484.69\,m^3/h$$



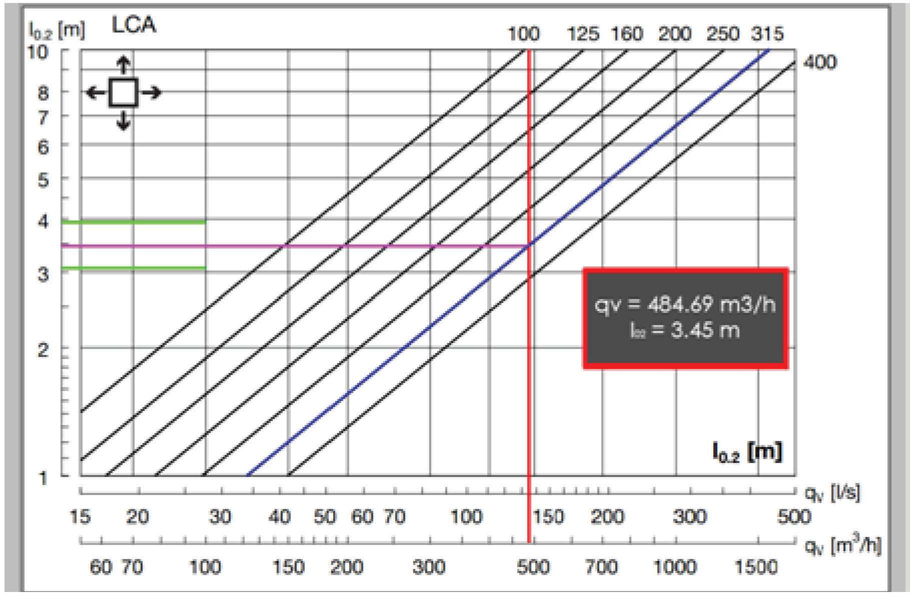
4-Ways roof ventilation



Side-view of installation

Ill.128: 4-ways ventilation

The ventilation installation is 4-ways, and attached to the ceiling. The installation dimension is Ø315 mm. As shown in the graph below.



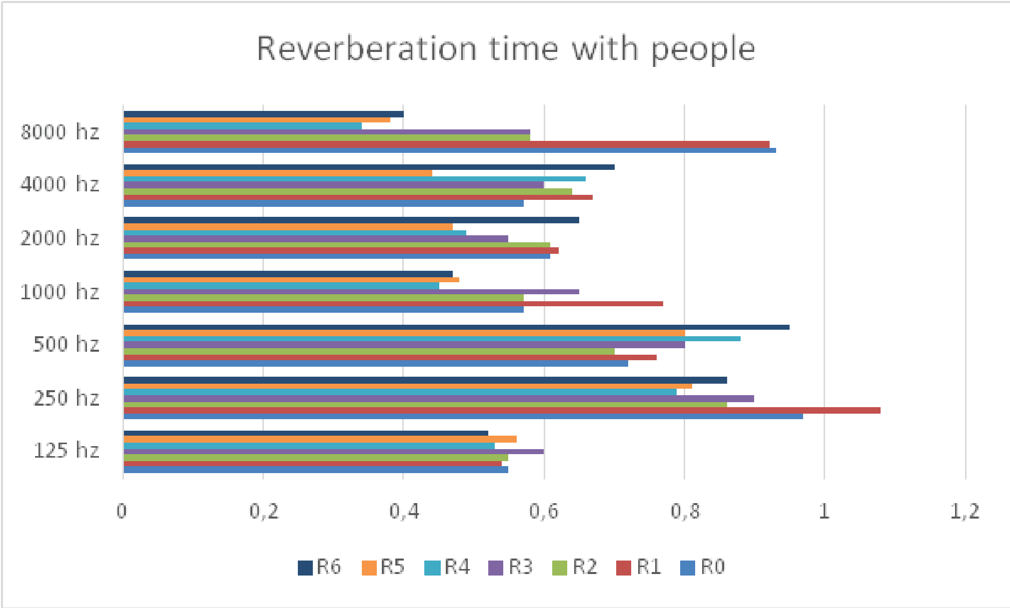
The red stroke indicates airflow rate, while the blue stroke indicates the chosen installation size dimension (which is Ø315 mm). The green stroke shows the interval it has to be between [3.14;3.95]. While the purple stroke indicated the penetration depth, which is approximately 3.45 m.

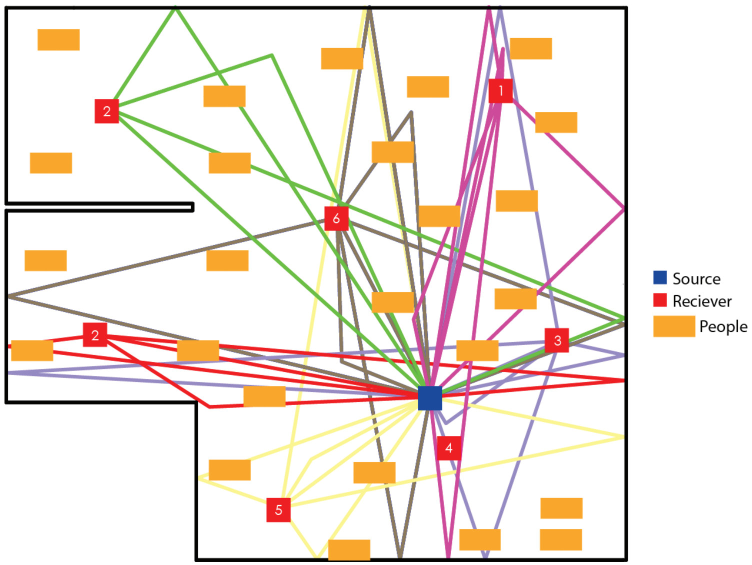
Ill.129: Diagram of different fixtures

APPENDIX 4: ACCOUSTICS

Acoustically the aim for reverberation time in kindergarten is between 0.4-0.8s. The calculation has been done through Pachyderm, which is a plug-in for rhino, and made for one of the group rooms. Where there have been used three different materials, gypsum walls, bamboo flooring, and troldtek ceiling. Parigi (2015)

As the graph shows, the reverberation times are approximately around 1.8s, which are way higher than what is required in a kindergarten, but the results shown above is without people load and furniture. Which is why, there have been made further analysis, so to see if that would make enough of a difference, which can be seen below. The results are satisfying with people included in the analysis.

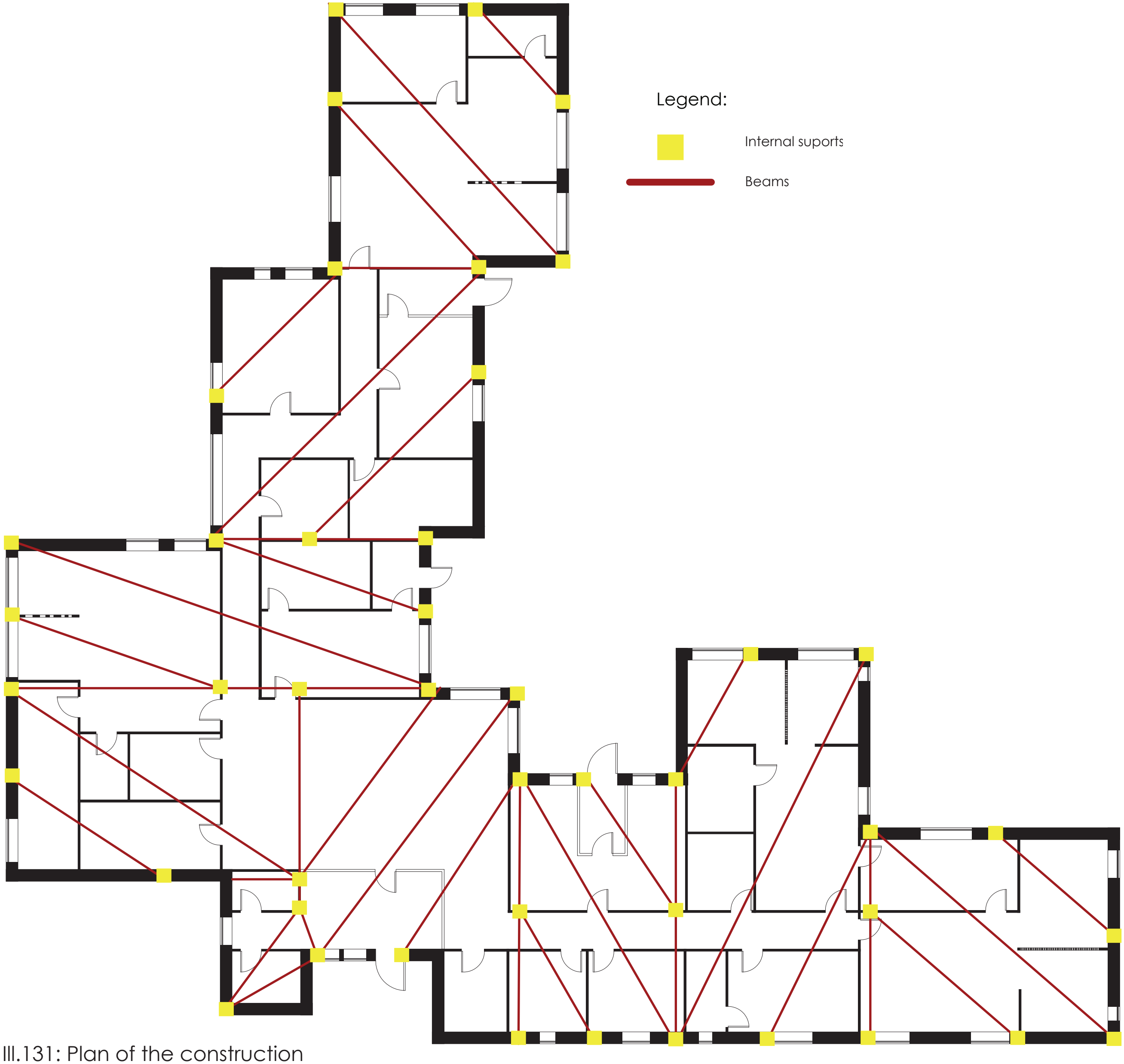




Ill.130: Accoustic rays

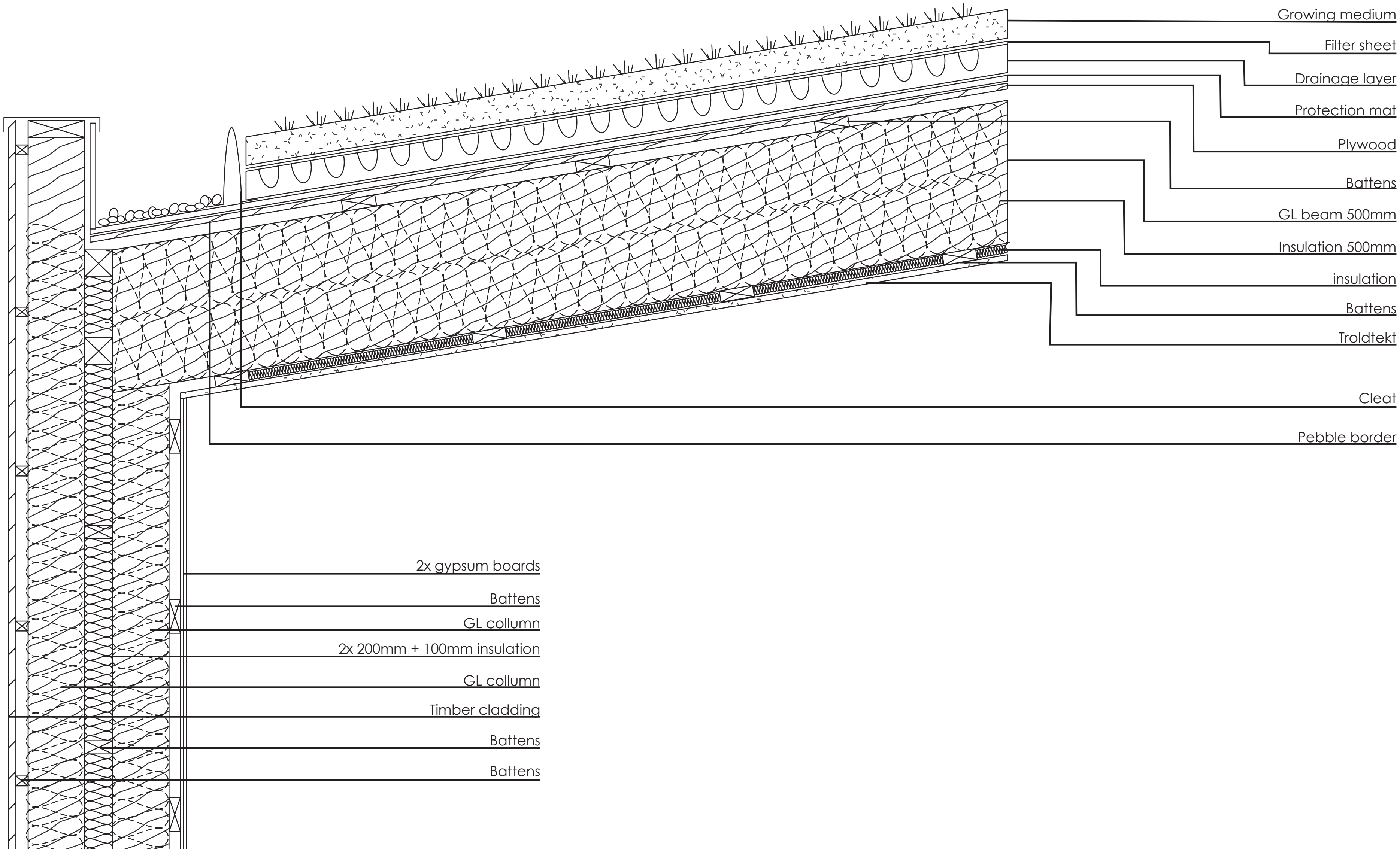
APPENDIX 5: CONSTRUCTION

The structural system chosen for this project is a balloon frame with GL beams and interior columns in steel to reduce the cross sections. For this, there has been taken inspiration from a case study of the structural system of the new Karolinelund kindergarten for the sizes of our GL beams and steel columns. Here the beams are between 360 x 115mm and 500 x 190mm and the steel columns in the interior walls have a cross section between RHS 70x70x5 and RHS 100x100x6.
Therefore it has been chosen, based on the case study of the new Karolinelund kindergarten, that the columns are going to be RHS 100x100x6 and the beams are going to be GL 500 x 190mm.



Ill.131: Plan of the construction

APPENDIX 6: DETAIL DRAWING

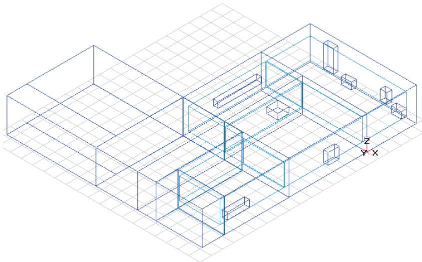


Ill.132: Detail drawing of the roof and exterior wall 1-20

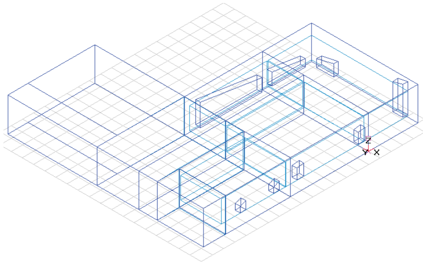
APPENDIX 7: BSIM

	Option 1		Option 2		Option 3	
	Hour over 26 degrees	Hours over 27 degrees	Hour over 26 degrees	Hours over 27 degrees	Hour over 26 degrees	Hours over 27 degrees
Big group room	59	34	55	32	53	32
Small group room	63	35	55	33	52	33
Break room	55	34	51	32	51	32
Grapple room	51	32	54	34	52	32

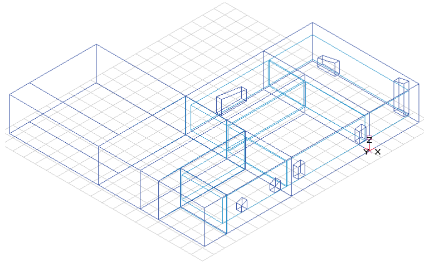
Ill.133: Results from bsim



Ill.134: Option 1



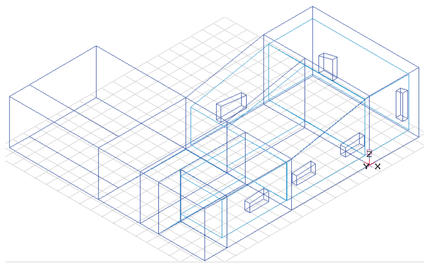
Ill.135: Option 2



Ill.136: Option 3

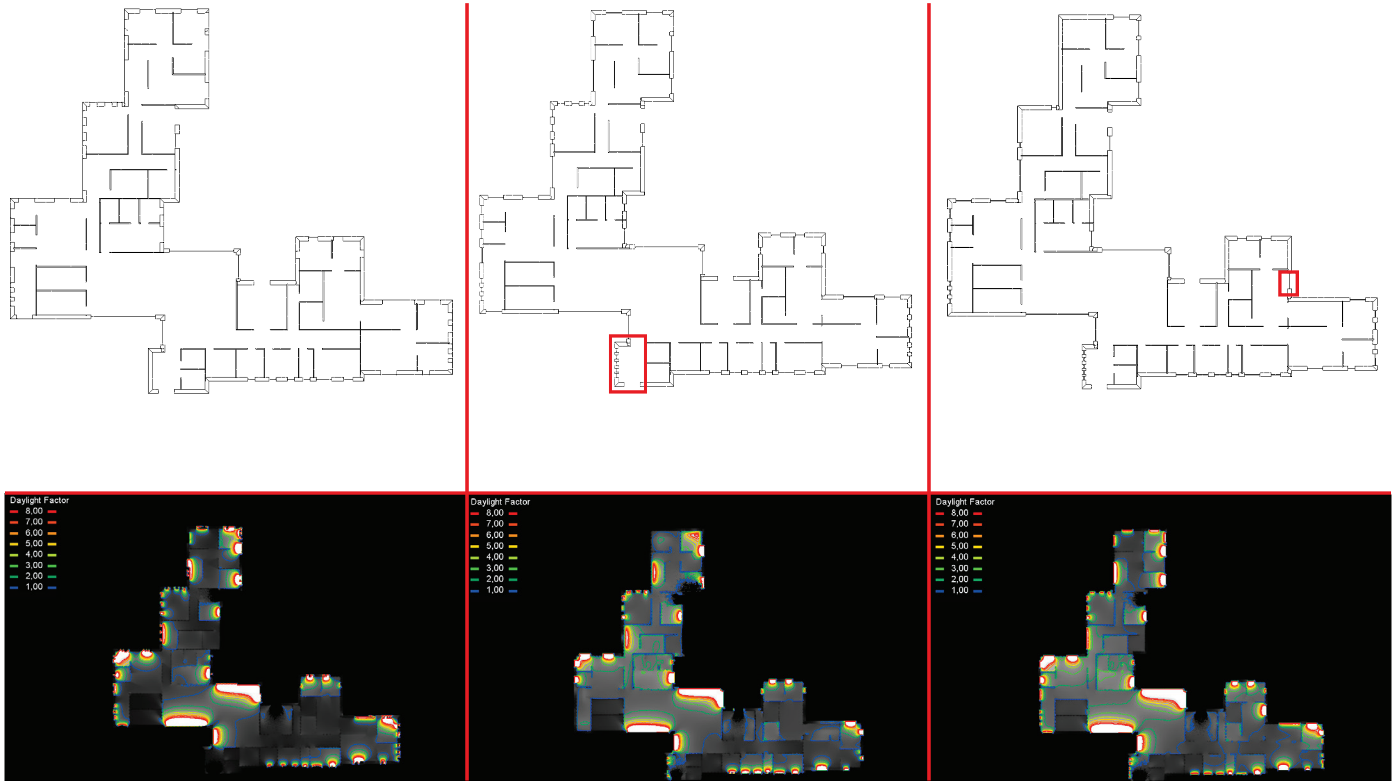
	Final version	
	Hour over 26 degrees	Hours over 27 degrees
Big group room	49	23
Small group room	51	24
Break room	54	25
Grapple room	53	25

Ill.137: Results from bsim

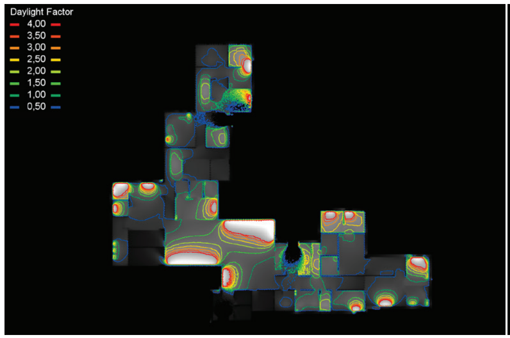


Ill.138: Final version

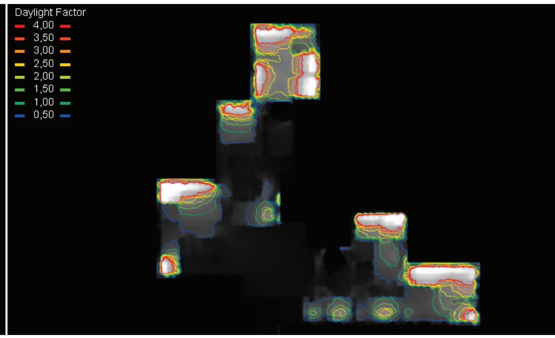
APPENDIX 8: LIGHT ANALYSIS



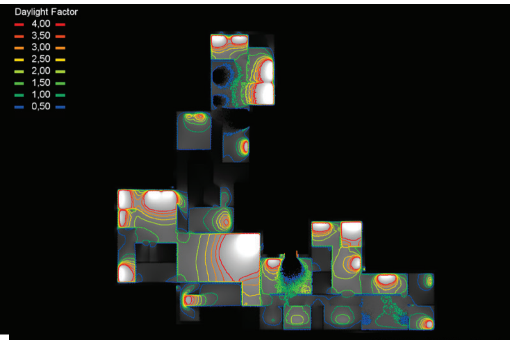
Ill.139: The tree first versions of velux light analysis



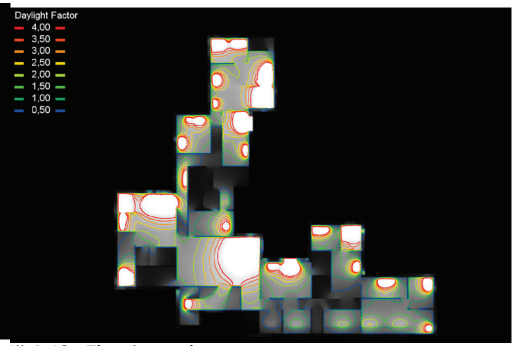
Ill.140: Option 1



Ill.141: Option 2

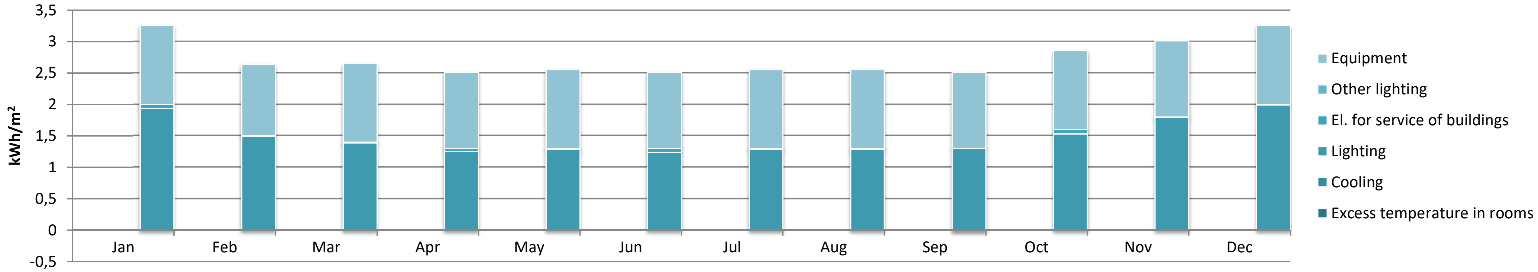


Ill.142: Option 3

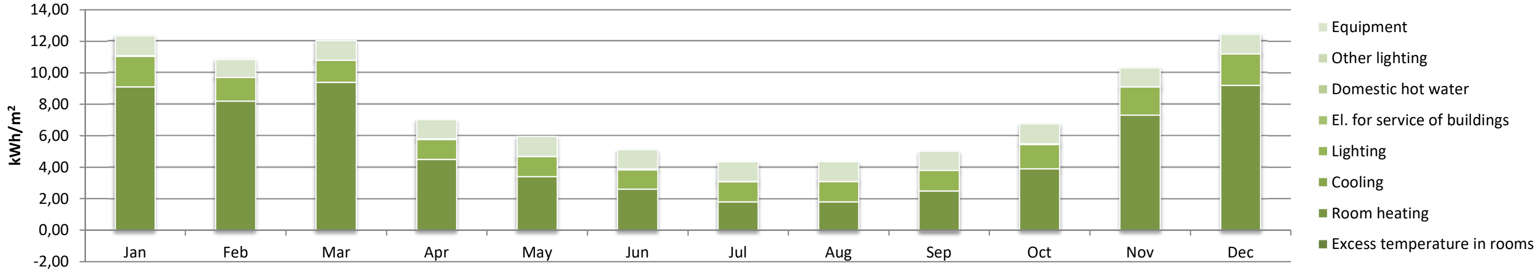


Ill.143: Final version

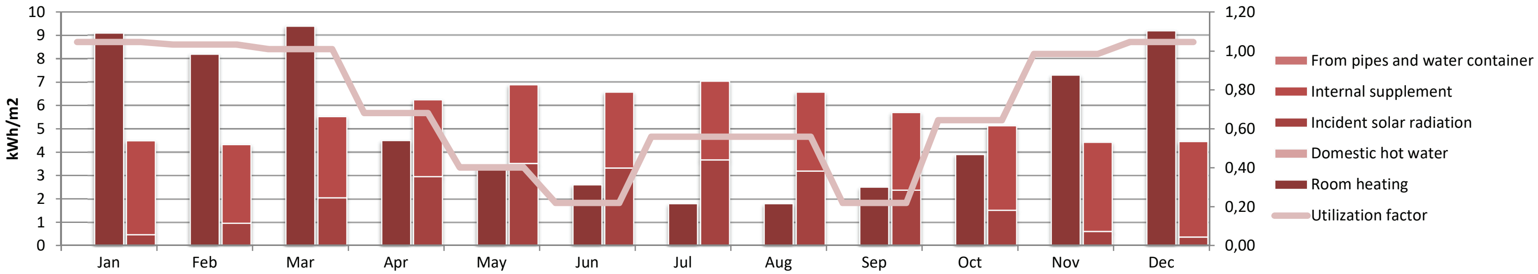
APPENDIX 9: BE15



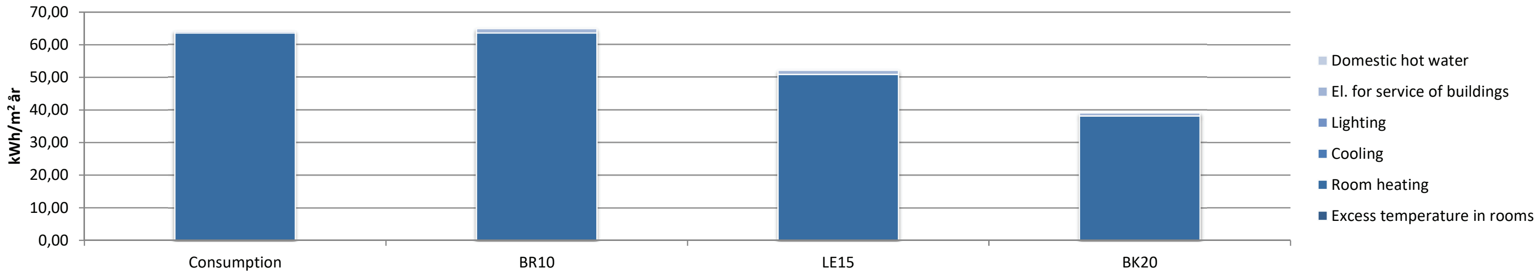
Ill.144: Option 1 - EL production vs. EL consumption



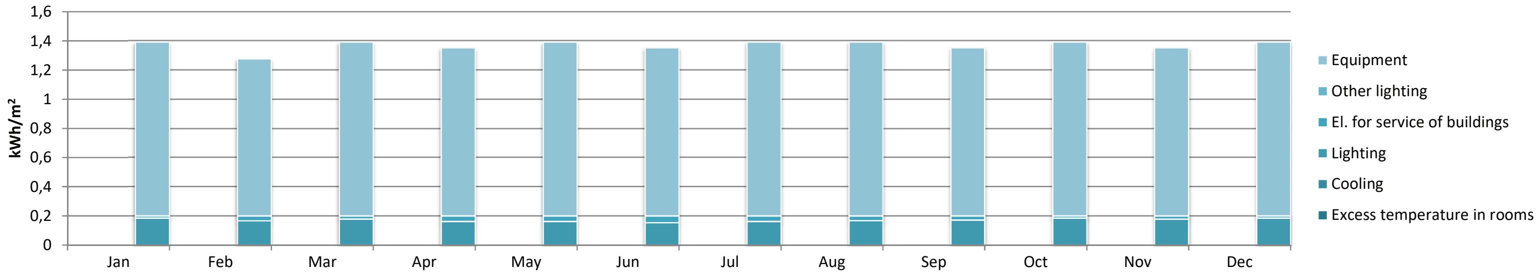
Ill.145: Option 1 - Energy consumption



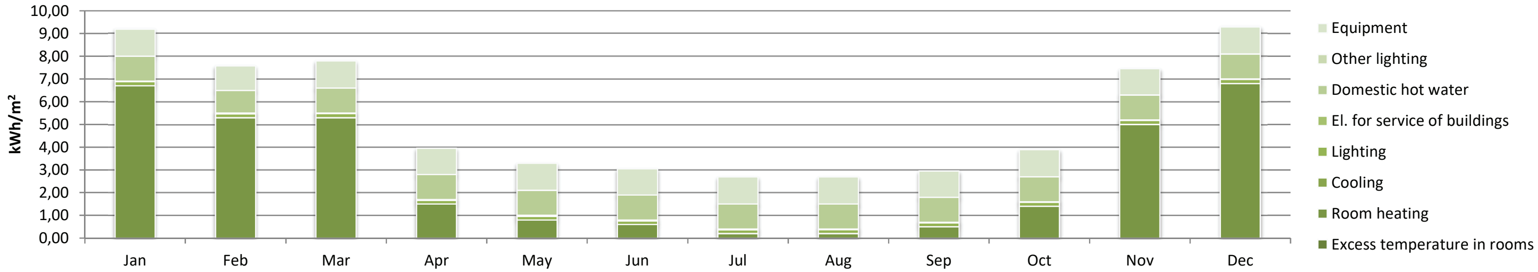
Ill.146: Option 1 - Heating demand vs. heat supply



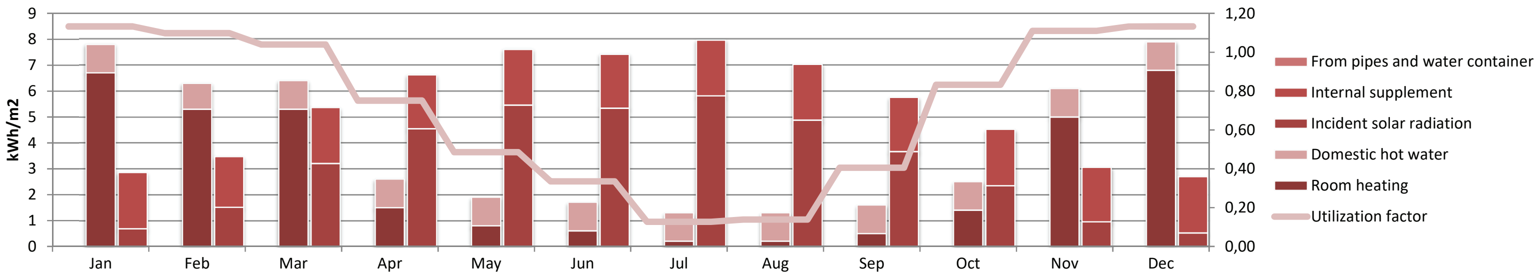
Ill.147: Option 1 - Energy frame



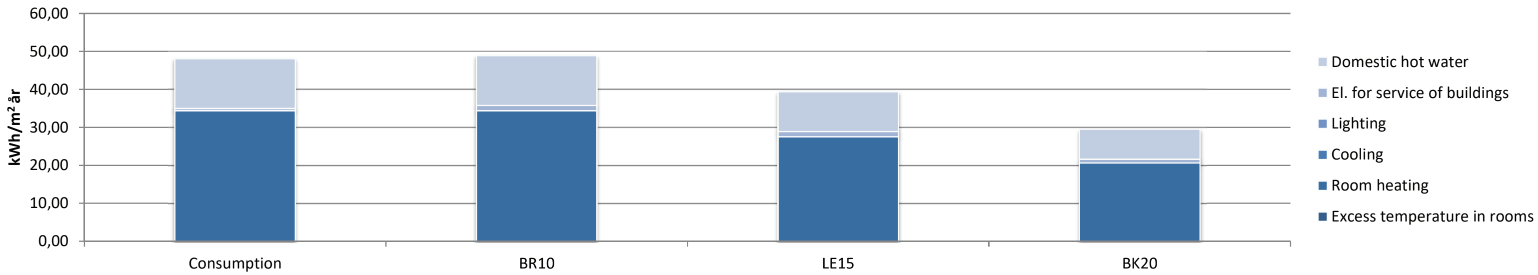
Ill.148: Option 2 - EL production vs. EL consumption



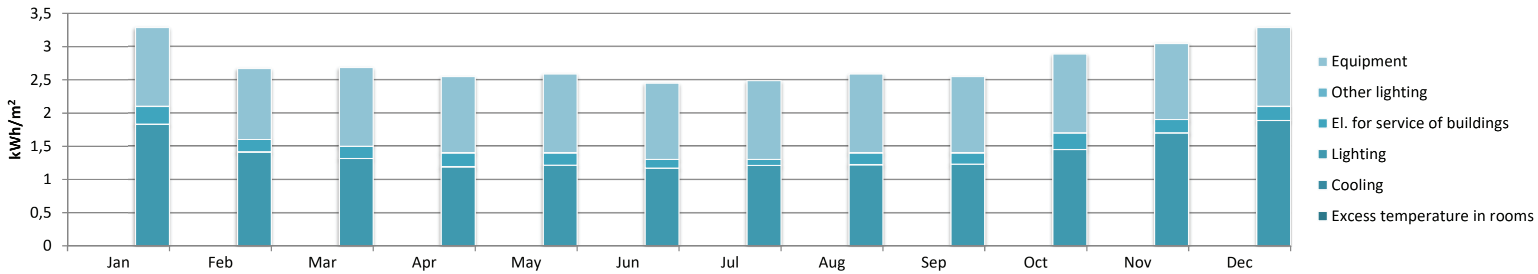
Ill.149: Option 2 - Energy consumption



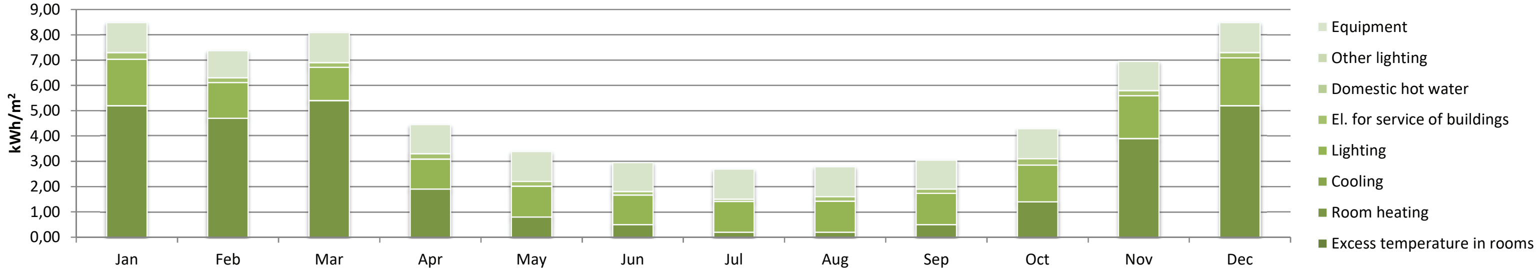
Ill.150: Option 2 - Heating demand vs. heat supply



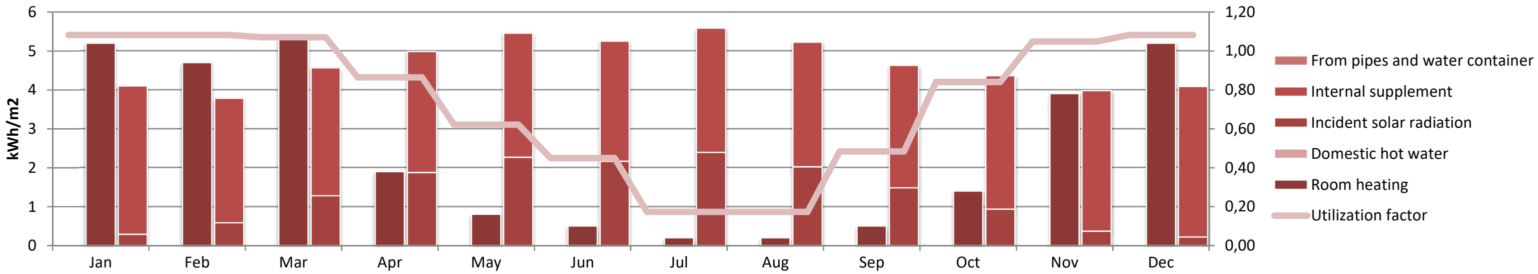
Ill.151: Option 2 - Energy frame



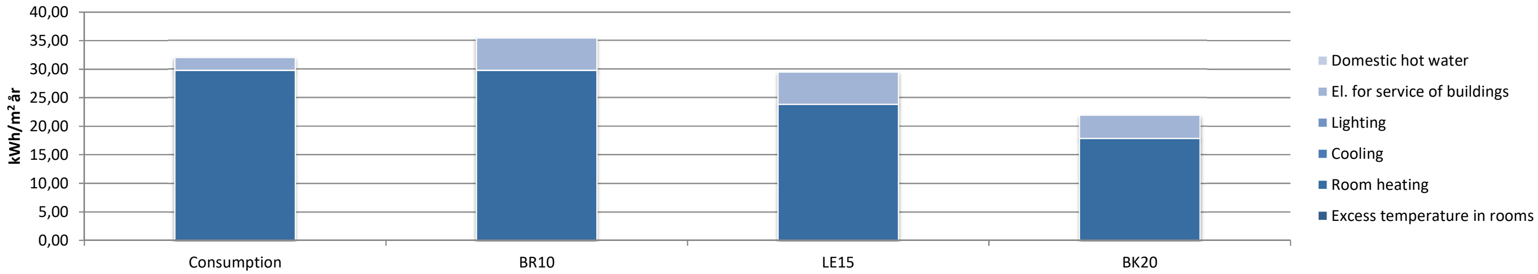
Ill.152: Option 3 - EL production vs. EL consumption



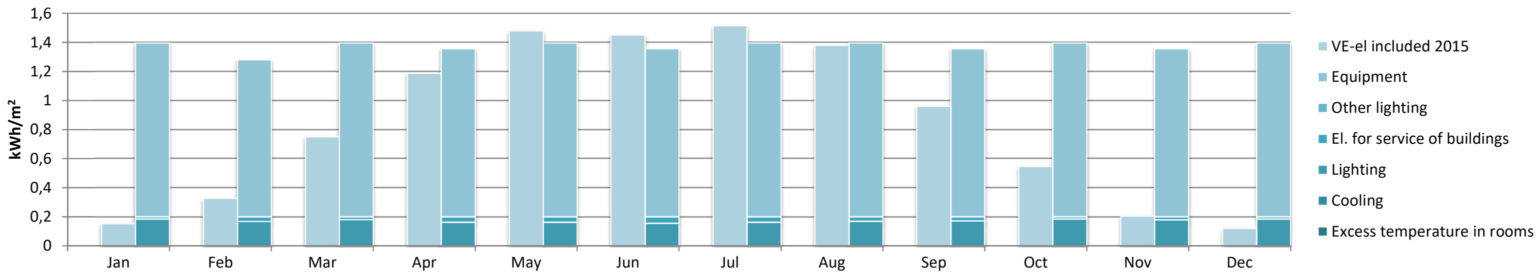
Ill.153: Option 3 - Energy consumption



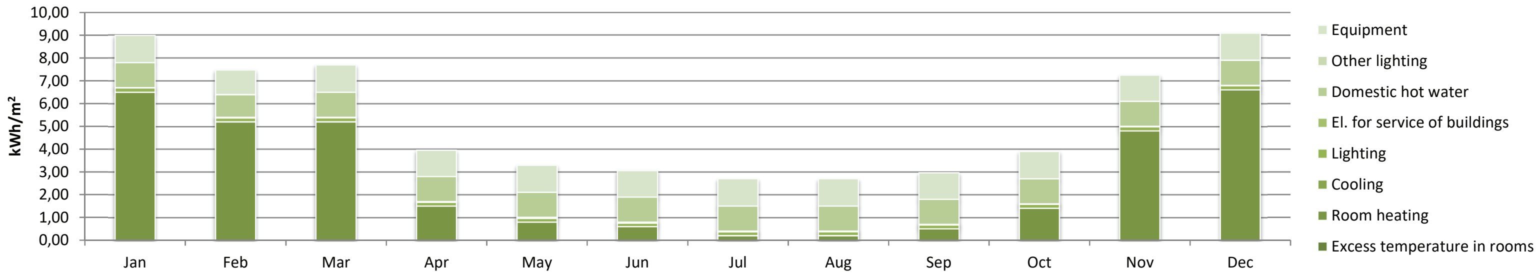
Ill.154: Option 3 - Heating demand vs. heat supply



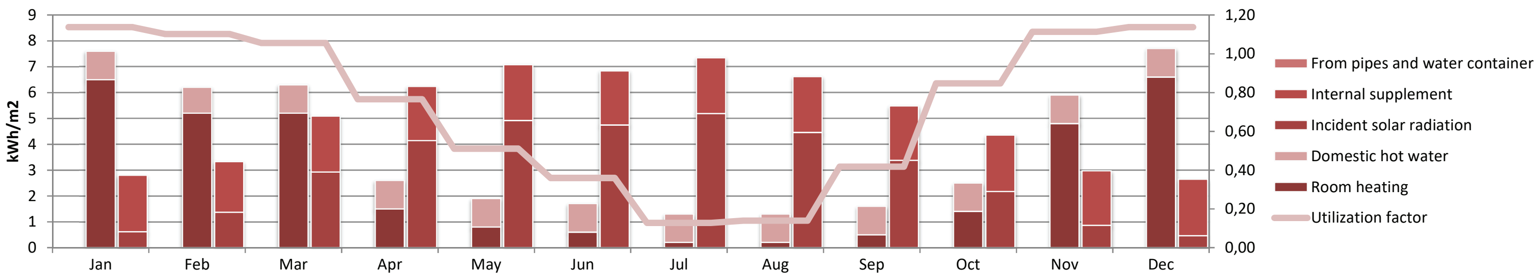
Ill.155: Option 3 - Energy frame



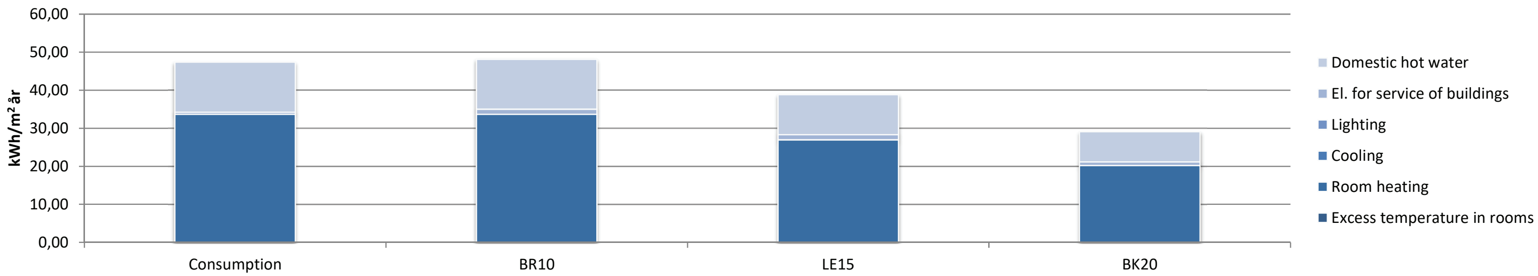
Ill.156: Final version - EL production vs. EL consumption



Ill.157: Final version - Energy consumption



Ill.158: Final version - Heating demand vs. heat supply



Ill.159: Final version - Energy frame